Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

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HNOLOGY DEPARTMENT

Rolled Steel

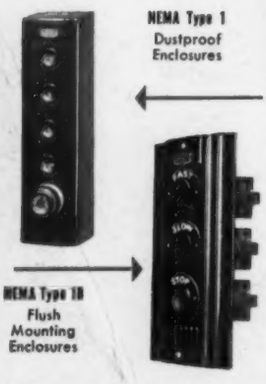
PITTSBURGH ROLLS for rail mills are excellent for the service required—an opinion confirmed by operating men throughout the steel industry whose main interest is *less cost per ton of steel rolled.*

PITTSBURGH ROLLS

PITTSBURGH ROLLS Division of Blaw-Knox Company • PITTSBURGH, PA.

C-H SPECIAL SERVICE

Heavy Duty Pushbutton Enclosures



Also a complete line of one-hole and base mounting elements without enclosure.

NEMA 4 Water-tight
NEMA 5 Dust-tight
NEMA 7 For hazardous Vapors
NEMA 9 For hazardous Dust
From 1 to 6 Heavy Duty Elements

Also Oil-tight Construction

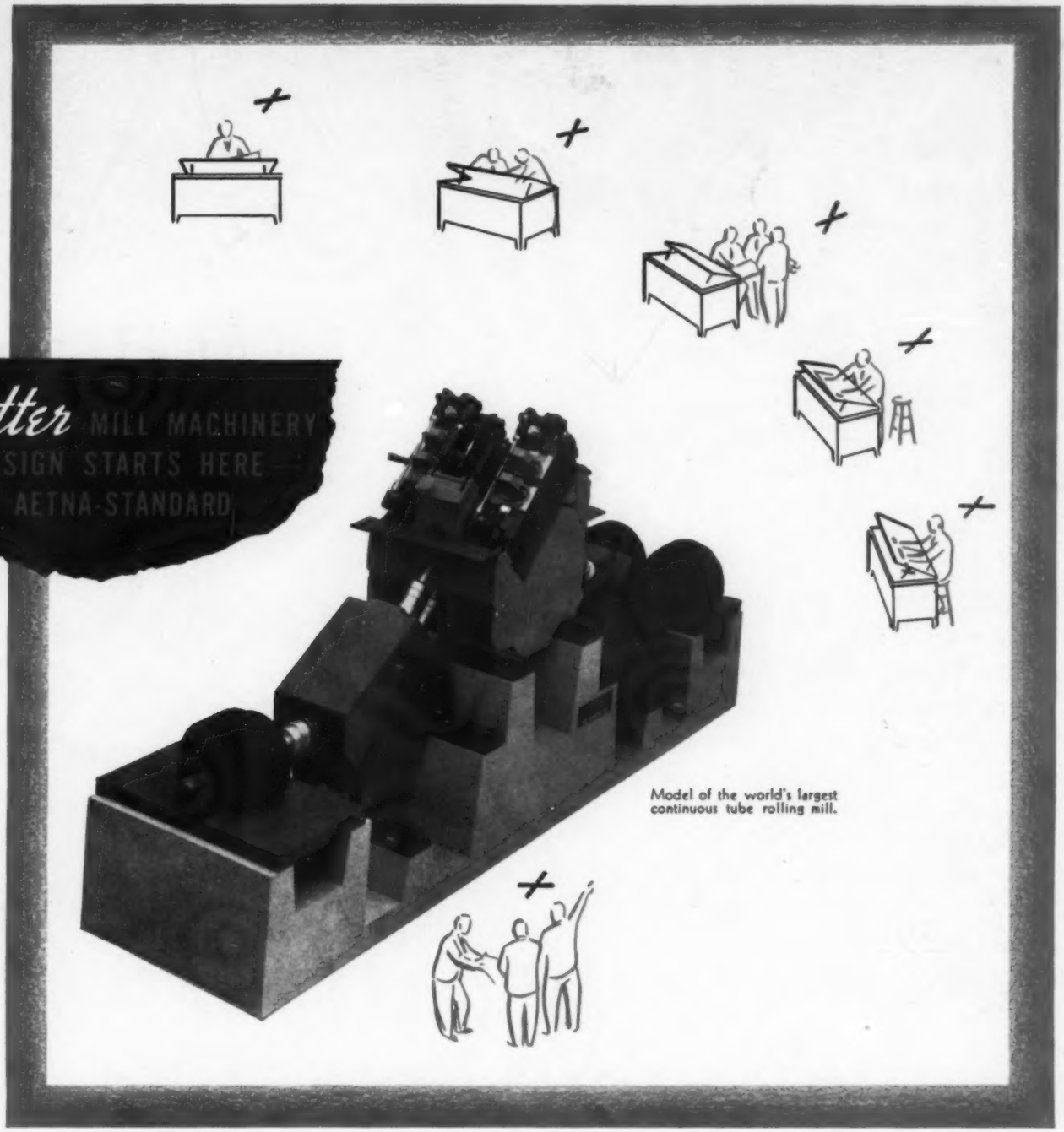
Oil-tight construction that really keeps oil out. Oilproof Neoprene gaskets positively prevent oil seepage.

•

Cutler-Hammer now offers a broad range of pushbutton stations and pushbutton elements for special service of every kind.

Typical of the line, the oil-tight stations conforming to automotive and machine tool standards, offer superlative engineering. *Oilproof* Neoprene gaskets positively seal out oil; large rugged terminals abolish the need to form a loop in wiring; oversize mushroom type operating buttons with drip-hoods and guard flanges . . . these are just a few of the scores of construction, operation and installation superiorities that show why machine builders and machine users prefer Cutler-Hammer pushbutton elements and stations and say they have no equal. Write for full information today. CUTLER-HAMMER, Inc., 1269 St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H



Model of the world's largest continuous tube rolling mill.

For each group of mill products . . . flat-rolled, tubular, finishing, etc., Aetna-Standard has engineering and design specialists.

These men, together with executive engineers, devote a part of their talents and energies to the future . . . improving the efficiency of machines.

Many industry developments have originated with you, the customer, and the refinement of the ideas has been the result of close co-operation between the shirt-sleeve specialists of your company and Aetna-Standard.

Converting ideas into productive production to help you produce, form, and process steel, brass, copper, or aluminum efficiently, is the business of The Aetna-Standard Engineering Company.

Our products number into the hundreds under these major classifications: Seamless Tube Mills; Continuous Butt Weld Pipe Mills; Coating Equipment; Continuous Galvanizing and Tinning; Drawbenches: Rolling Mills; Flat-Rolled Finishing Equipment.

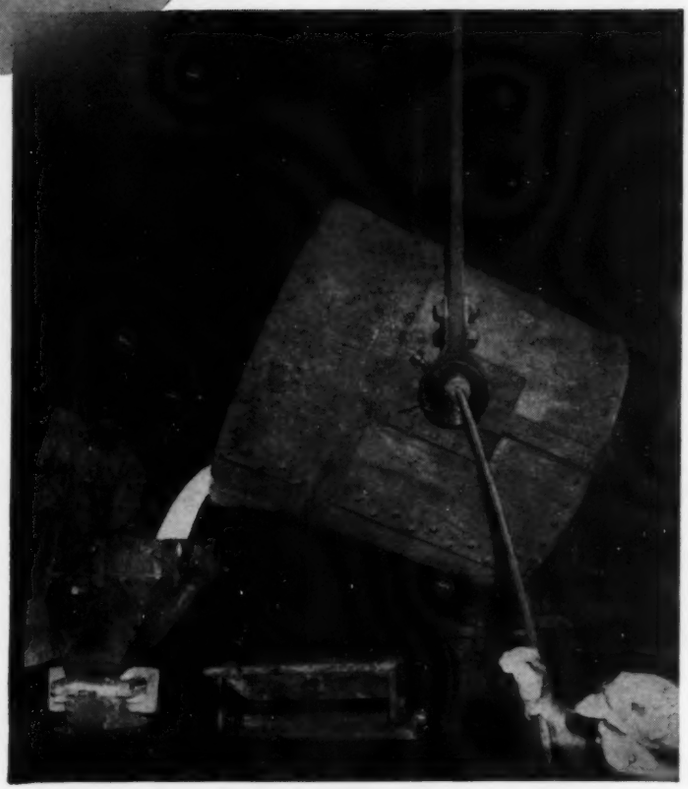
THE AETNA-STANDARD ENGINEERING COMPANY
YOUNGSTOWN, OHIO

ASSOCIATED COMPANY: HEAD, WRIGHTSON & COMPANY, LTD., MIDDLESBROUGH, ENGLAND

Check *everything!*

. . . TAKE NOTHING FOR GRANTED

Skilled foundrymen "who check everything — take nothing for granted" guide the pouring of roll castings at National. Constant control over metallurgical and physical properties is maintained by our laboratory staff. Precautions like these eliminate flaws. Strength and durability are assured. Such painstaking care in production details is reflected in sound, long-wearing rolls. Just ask National Roll users — they're our best salesmen.



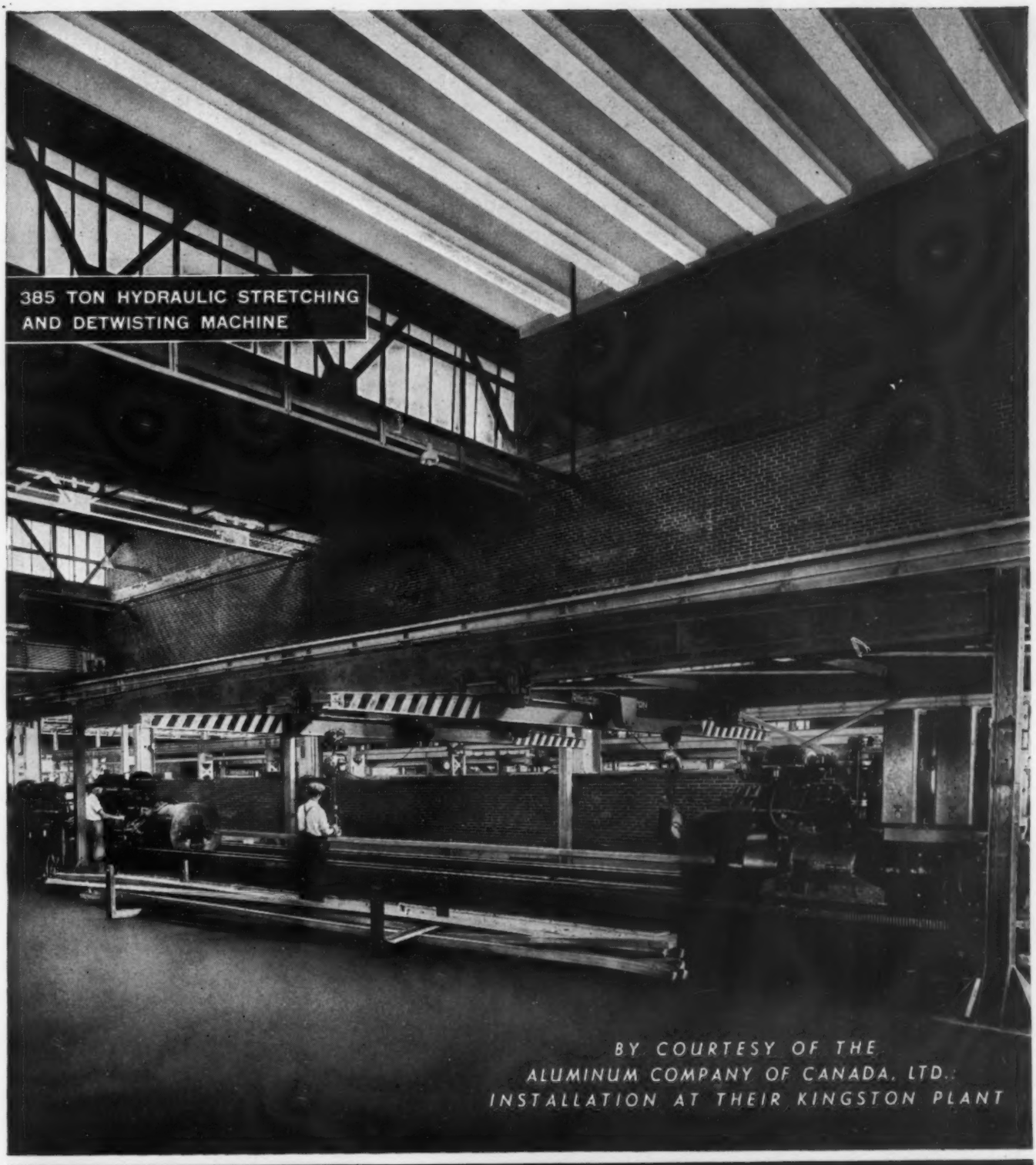
Pouring a chill roll in the National iron foundry

NATIONAL ROLLS
TRADE MARK REG.

National Rolls

THE NATIONAL ROLL & FOUNDRY CO.
AVONMORE, PENNSYLVANIA

Manufacturing IRON AND ALLOY IRON ROLLS *Exclusively*


385 TON HYDRAULIC STRETCHING
AND DETWISTING MACHINE
BY COURTESY OF THE
ALUMINUM COMPANY OF CANADA, LTD.
INSTALLATION AT THEIR KINGSTON PLANT

HYDR PRESS · INC.

VISIT OUR
BOOTH 249
WESTERN METAL
EXPOSITION
MARCH 22 to 27, 1947
CIVIC AUDITORIUMS
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ENGINEERS CONTRACTORS

HYDRAULIC PRESSES · ROLLING MILLS · PUMPS
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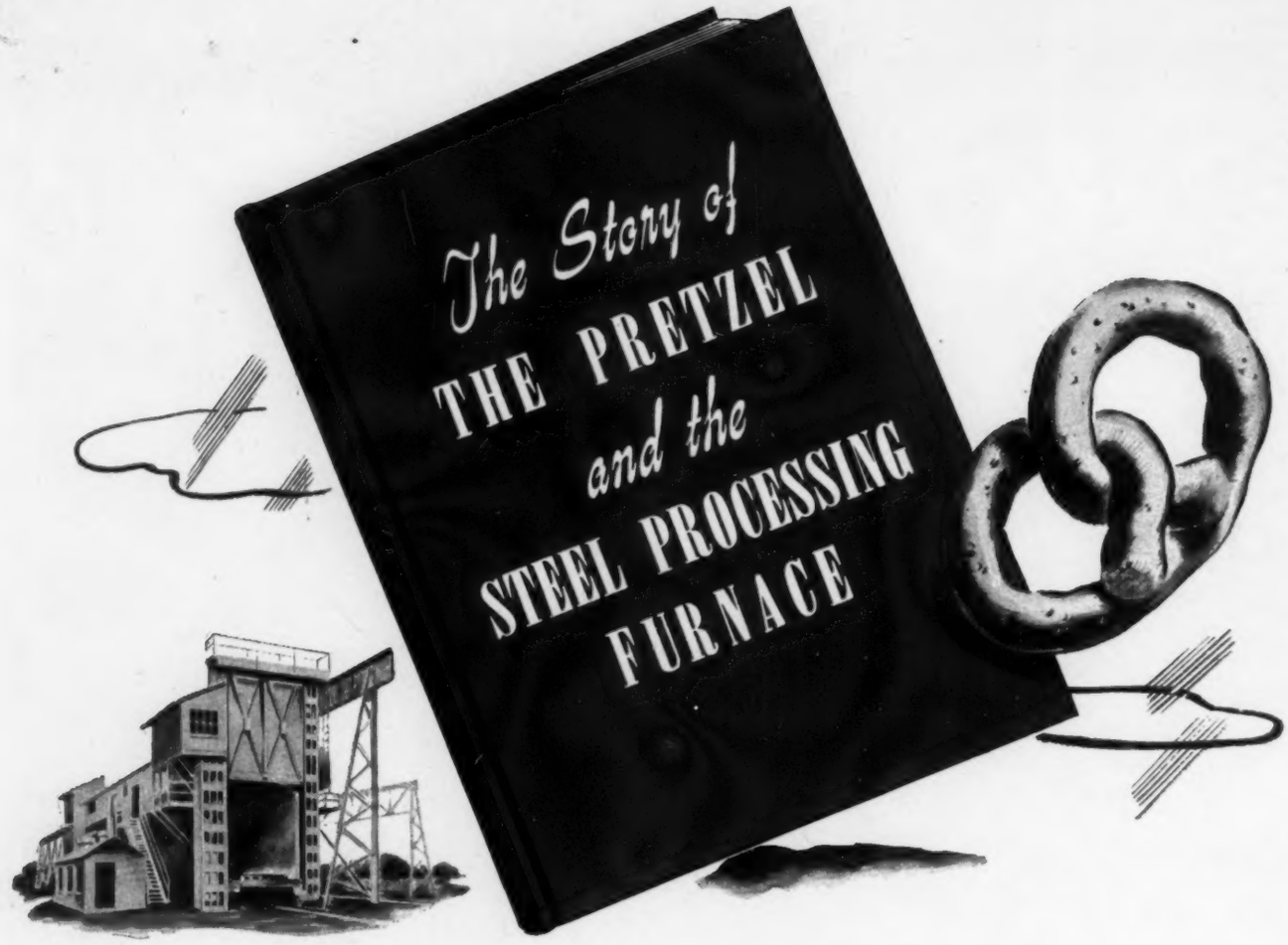
566-568 LEXINGTON AVENUE · NEW YORK 22 · N. Y.



You wouldn't think a pretzel had any relation to a steel processing furnace. But it does, and here's why:

A baking company recently lined a pretzel oven with B&W K-20 Insulating Firebrick. Immediate results—*50% reduction in baking time (6 minutes to 3 minutes) and over 57% reduction in heating-up time from a cold start (7 hours to 3 hours).*

Of course your business is different, but whether it's producing pretzels or processing steels in annealing, spheroidizing, forging, billet-heating, stress relieving or any other heating furnaces—it's B&W Insulating Firebrick that helps to do the trick better and more economically.

Because they are the lightest in their class, B&W I.F.B. have the lowest heat conductivity and lowest heat storage capacity. Furnaces lined with B&W I.F.B. come to operating temperature quickly, require less fuel to operate. This means cycle time is substantially cut: overall operating costs go down —production goes up.

Throughout the country, B&W Refractory Engineers are guiding progressive industries to reduced costs through increased furnace operating efficiency. Why not take advantage of their practical training and years of experience? A call or a post card will bring your local B&W Representative.

R-277

B&W

Water-Tube Boilers, for Stationary Power Plants, for Marine Service . . . Water-Cooled Furnaces . . . Superheaters . . . Economizers . . . Air Heaters . . . Pulverized-Coal Equipment . . . Chain-Grate Stokers . . . Oil, Gas and Multifuel Burners . . . Seamless and Welded Tubes and Pipe . . . Refractories . . . Process Equipment.

BABCOCK & WILCOX

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REFRACTORIES DIVISION
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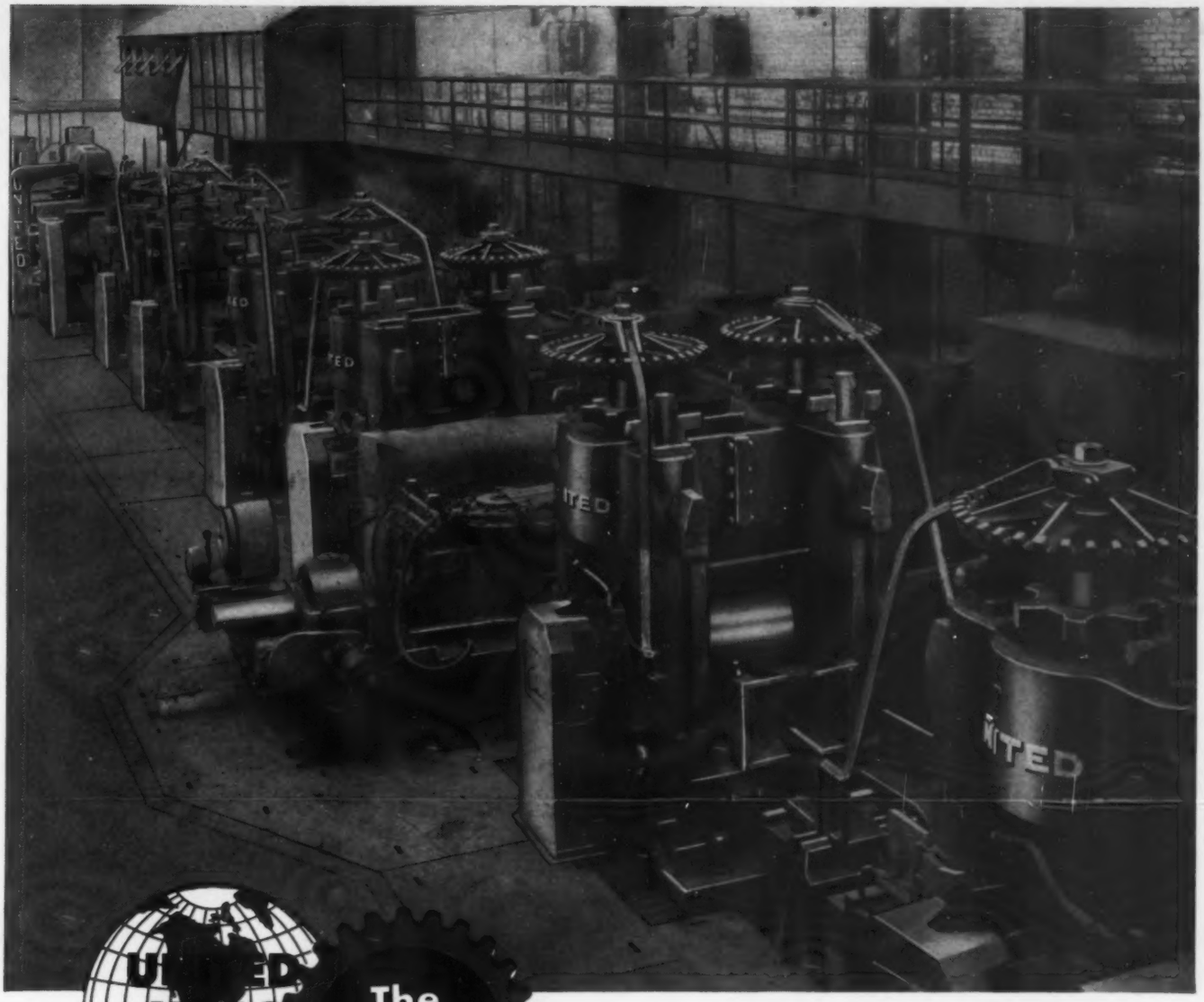


UNITED 21"—6 Stand Billet Mill

The World Over

IN Canada, South America, Mexico, England, France, Belgium, Russia, China, India and other countries of the world . . . United equipment is helping to meet the demand for increased steel tonnage.

Here at home, UNITED designed and built mills and machinery are in use in practically every prominent rolling mill plant in the ferrous and non-ferrous industries, and in hundreds of other plants engaged in special rolling of metals of every conceivable shape and analysis.

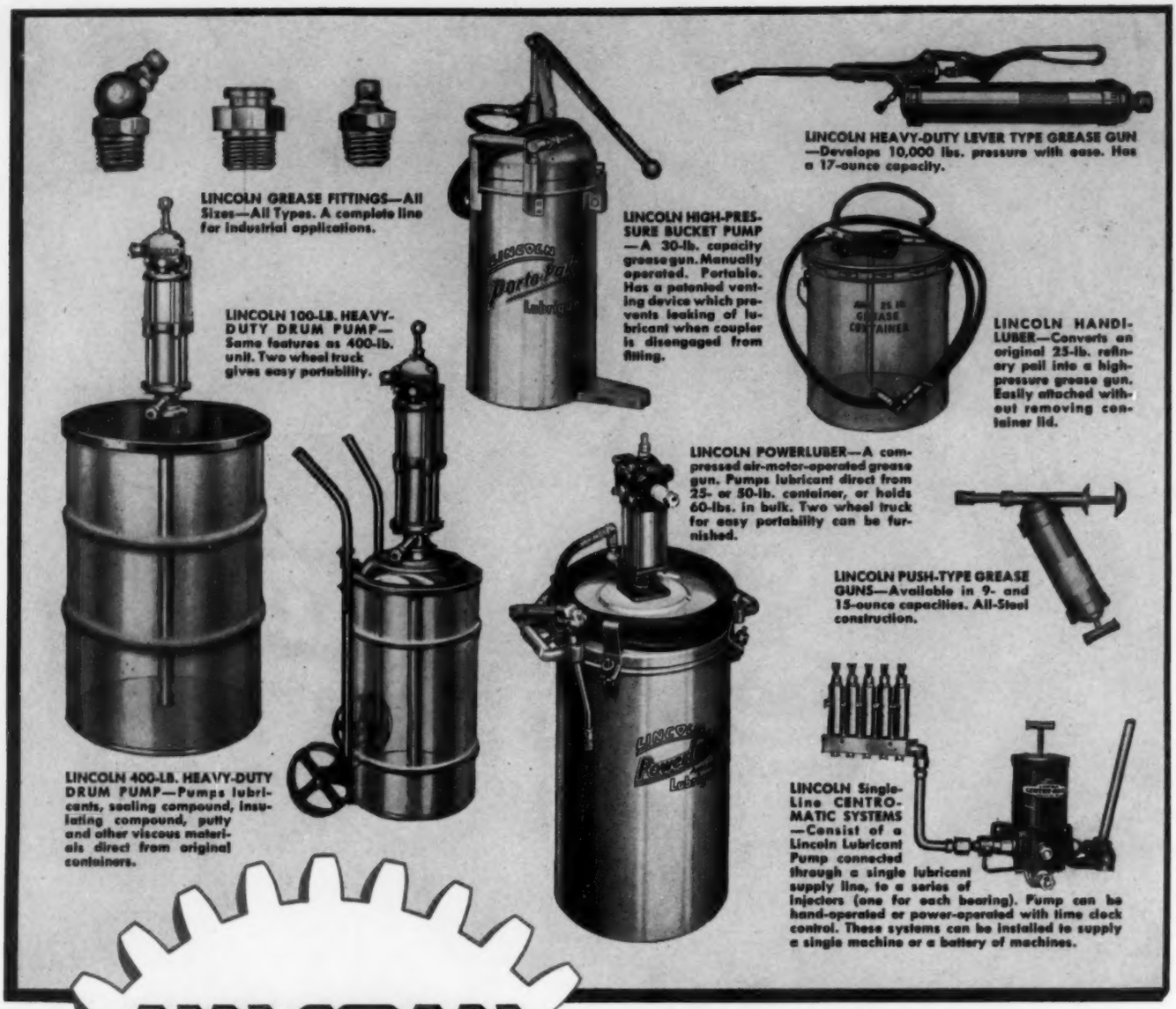
This universal acceptance of UNITED products is the result of sound engineering, constant research and more than 45 years progressive development in design and construction of rolling mills and auxiliary equipment.

UNITED's engineers are singularly fitted to deal with *your* rolling problems. Why not consult them.

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PENNSYLVANIA

Plants at Pittsburgh • Vandergrift • New Castle • Youngstown • Canton
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q. Canada



LINCOLN GREASE FITTINGS—All Sizes—All Types. A complete line for industrial applications.

LINCOLN HEAVY-DUTY LEVER TYPE GREASE GUN—Develops 10,000 lbs. pressure with ease. Has a 17-ounce capacity.

LINCOLN HIGH-PRESSURE BUCKET PUMP—A 30-lb. capacity grease gun. Manually operated. Portable. Has a patented venting device which prevents leaking of lubricant when coupler is disengaged from fitting.

LINCOLN HANDI-LUBER—Converts an original 25-lb. refinery pail into a high-pressure grease gun. Easily attached without removing container lid.

LINCOLN 100-LB. HEAVY-DUTY DRUM PUMP—Same features as 400-lb. unit. Two wheel truck gives easy portability.

LINCOLN POWERLUBER—A compressed air-motor-operated grease gun. Pumps lubricant direct from 25- or 50-lb. container, or holds 60-lbs. in bulk. Two wheel truck for easy portability can be furnished.

LINCOLN PUSH-TYPE GREASE GUNS—Available in 9- and 15-ounce capacities. All-Steel construction.

LINCOLN 400-LB. HEAVY-DUTY DRUM PUMP—Pumps lubricants, sealing compound, insulating compound, putty and other viscous materials direct from original containers.

LINCOLN Single-Line CENTRO-MATIC SYSTEMS—Consist of a Lincoln Lubricant Pump connected through a single lubricant supply line, to a series of injectors (one for each bearing). Pump can be hand-operated or power-operated with time clock control. These systems can be installed to supply a single machine or a battery of machines.

LINCOLN

Lubricating Equipment

Engineered to Protect and Increase the Productive Service-Life of Your Machinery

Regardless of plant lubrication requirements—either a complete centralized system or grease fittings and hand guns—Lincoln can supply the lubricating equipment that will help increase the service life and output of your machines.

Stubborn lubrication problems are being solved daily through the use of Lincoln Lubricating Equipment. The line is complete and includes everything needed to give industry top lubrication efficiency. A few of the many Lincoln products are illustrated above.

Pioneer Builders of Engineered Lubricating Equipment

ASK YOUR *Lincoln* WHOLESALER

He has experienced men ready to help you with your lubrication problems and can supply your requirements. If there is no Lincoln wholesaler convenient, mail coupon for literature and complete information.

LINCOLN ENGINEERING COMPANY, ST. LOUIS 20, MO.

Gentlemen: Please send me catalog on Lincoln Industrial Lubricating Equipment ☐. I would like to have literature on Centro-Matic Lubricating Systems ☐.

*Name*_____

*Title*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

ISE 847-2

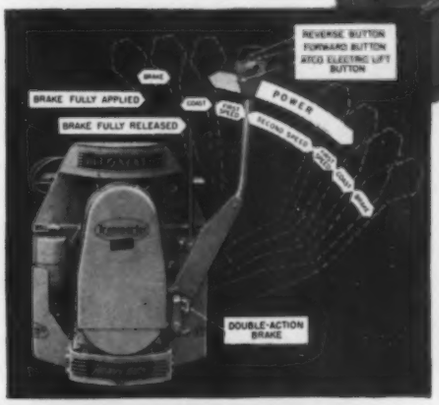
Announcing The New 1947 Transporter *with*

ATCO ELECTRIC LIFT

Proved by exhaustive tests to be the fastest and easiest operating motorized hand truck ever developed—the 1947 TRANSPORTER is the first motorized hand truck with electric-lift so efficient it uses a standard 11-plate battery—which makes it the lowest operating cost electric-lift hand truck you can buy.

"Automatic" engineers through intensive research have developed an electric-lift motor and hydraulic pump, which uses less current than the reserve left in the famous TRANSPORTER standard battery at the end of a full day's operation. Therefore, the TRANSPORTER still provides maximum power for a full day's hauling and yet uses only a light socket for charging battery.

A simple pressure of the forefinger on the new ATCO ELECTRIC LIFT BUTTON raises the loaded skid or pallet to moving height in SECONDS! In a normal day's operation, less than 10% of battery capacity is used to lift to maximum height—and since the lift is not always raised more than half the full height in actual work, the current consumption will be less.



REVERSE BUTTON and guide handle eases Transporter below skid or pallet, and load is ready to be raised to moving level. Requires no skill, no muscle work—just thumb pressure.

FOREFINGER PRESSES the ATCO Electric Lift, and your material is raised, ready to move. Human energy expenditure: practically nothing.

FORWARD BUTTON starts the load—4000 to 6000 pounds of materials glide along at safe walking speed. You deposit it with the same easy "touch-of-the-fingers" control.

Muscle Mike is the mighty midget of power in the TRANSPORTER that gets your material where you want it with new ease and lowest cost. Diagram shows how IN ONE MOTION and WITH ONE HAND, operator effortlessly controls every movement of your product with new ATCO ELECTRIC LIFT Model TRANSPORTER.

ONE HAND, ONE MOTION OPERATION

New double-position brake—applied either by raising or lowering guide handle, provides steering and braking leverage at the same time for hauling on ramps. All controls—forward and reverse speed, lift, steering and brake are so arranged they may be regulated by one hand and operated in one motion, simply by touching the buttons and guiding the handle.

Available in three standard units, 4000 and 6000 capacity platform model and 4000 pound capacity pallet model, TRANSPORTER also comes in companion models equipped with the ATCO Foot Lift at lower cost. Let an ATCO SPECIALIST show you how TRANSPORTERS end back-breaking, gruelling toil, release critical labor for more productive work, cut your material handling costs in half! Mail the coupon for complete facts. No obligation.

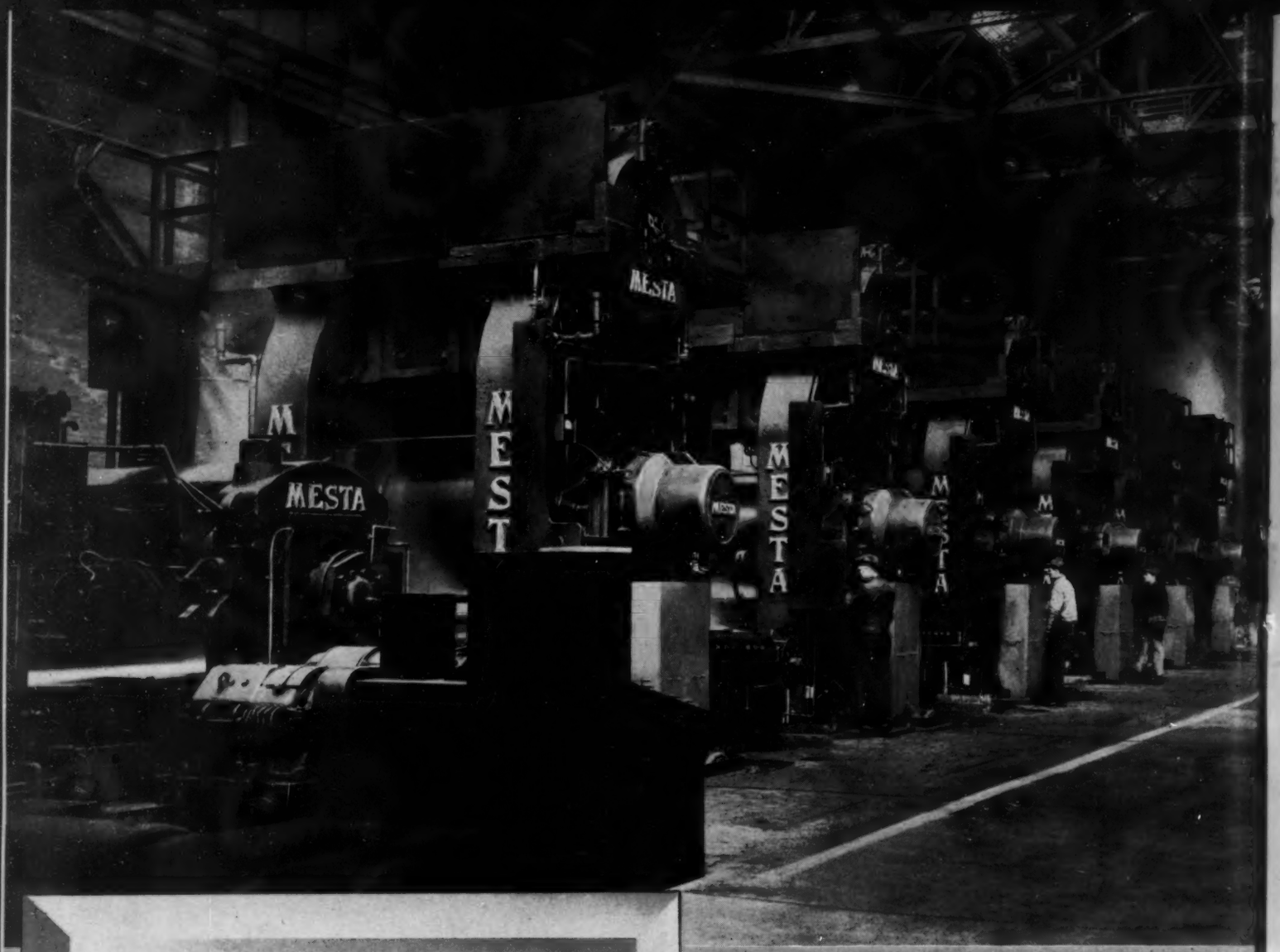
LOOK TO THE LEADER FOR ALL THAT'S NEW!

Transporter
A PRODUCT OF AUTOMATIC
Lightens LIFE'S LOADS

AUTOMATIC TRANSPORTATION COMPANY
DIV. OF THE YALE & TOWNE MFG. CO.
47 West 87th Street, Dept. B7,
Chicago 20, Illinois

Mail me without obligation, facts about the NEW ATCO ELECTRIC LIFT TRANSPORTER
( ) Have an ATCO Specialist survey my handling costs.

Company Name.....
By.....
Address.....
City.....*State*.....



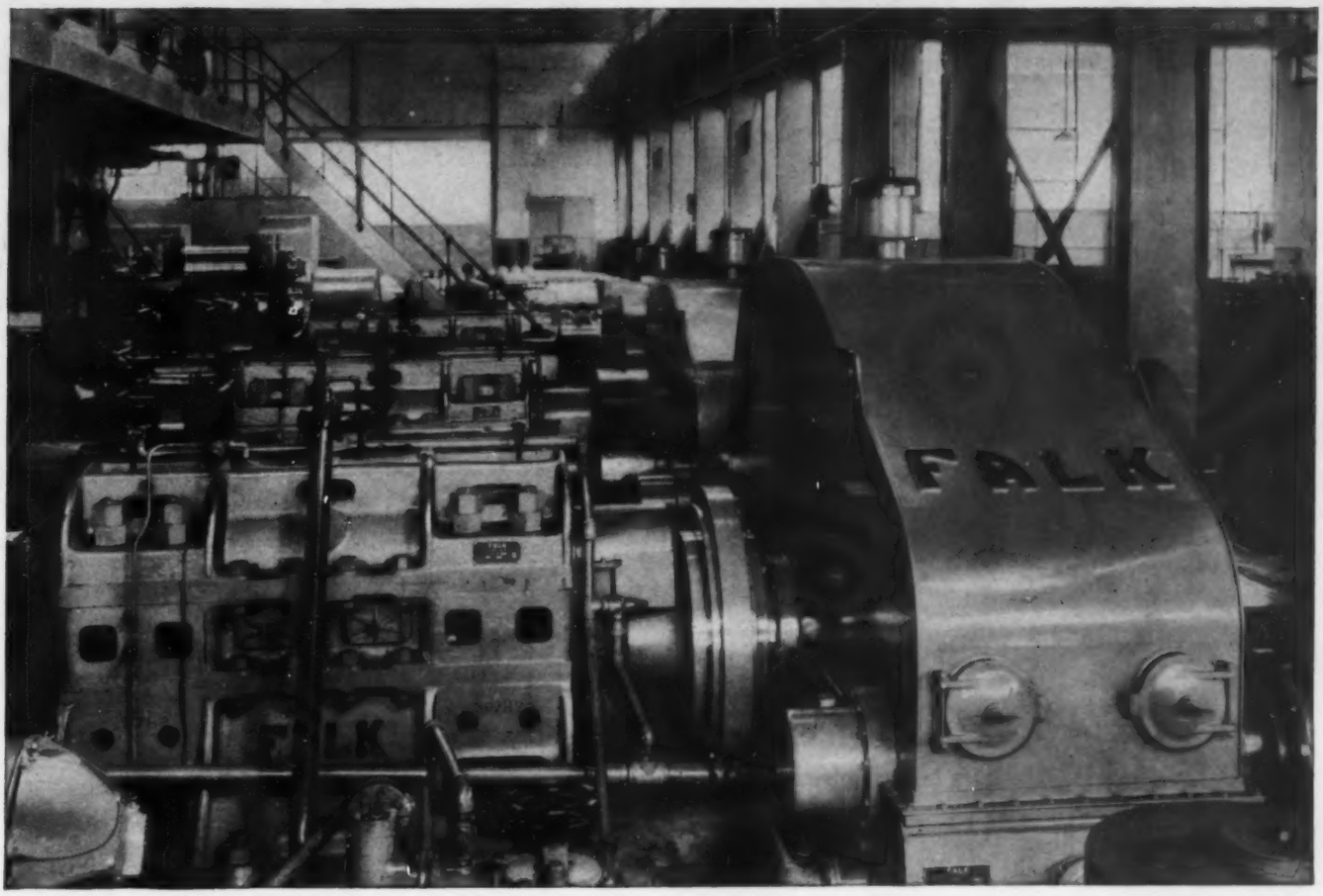
MESTA

Mesta 56 inch Four High
Continuous Hot Strip Mill
Installed at
Steel Company of Canada

Continuous

HOT STRIP MILLS

MESTA MACHINE COMPANY · · · PITTSBURGH, PA.



GEARS PROTECTED...because the lubricant carries the load

LUBRICATE your enclosed heavy duty gear drives and bearings with *Texaco Meropa Lubricants,* and you can stop worrying about wear. That's because the load-carrying capacity of *Meropa Lubricants* is greater than any shock loads or pressures that are encountered in the heaviest service.

Texaco Meropa Lubricants are extremely stable – have unusually high resistance to oxidation and thickening. They prevent bearing corrosion, will not separate in service or in storage, have exceptional adhesive properties, and do not foam.

Texaco Meropa Lubricants come in a complete line – meet the lubrication requirements of every type of enclosed gear drive. You'll also find them excellent for lubricating coiler, edger roll, slab shear and run-out drives, table manipulator gears and similar parts.

For Texaco Products and Lubrication Engineering Service, call the nearest of the more than 2300 Texaco distributing plants in the 48 states, or write:

The Texas Company, 135 East 42nd Street, New York 17, N. Y.

TEXACO

TEXACO Meropa Lubricants

FOR STEEL MILL REDUCTION GEARS

Tune in . . . TEXACO STAR THEATRE presents the NEW EDDIE BRACKEN SHOW every Sunday night. METROPOLITAN OPERA broadcasts every Saturday afternoon.

STEEL PRICES

COSTS COSTS COSTS COSTS COSTS

Maybe you'll find the answer in the BILLET SHED

How are you going to hold the profit line with fixed base prices and increased wages, advancing fuel prices, the possibility of higher freight rates . . . costs advancing generally?

Some mills are finding at least part of the answer in the billet shed.

They find that one man with a Bonnot Billeteer does the work of ten manual chippers . . . does it neater and better . . . releasing men for less killing, more profitable work.

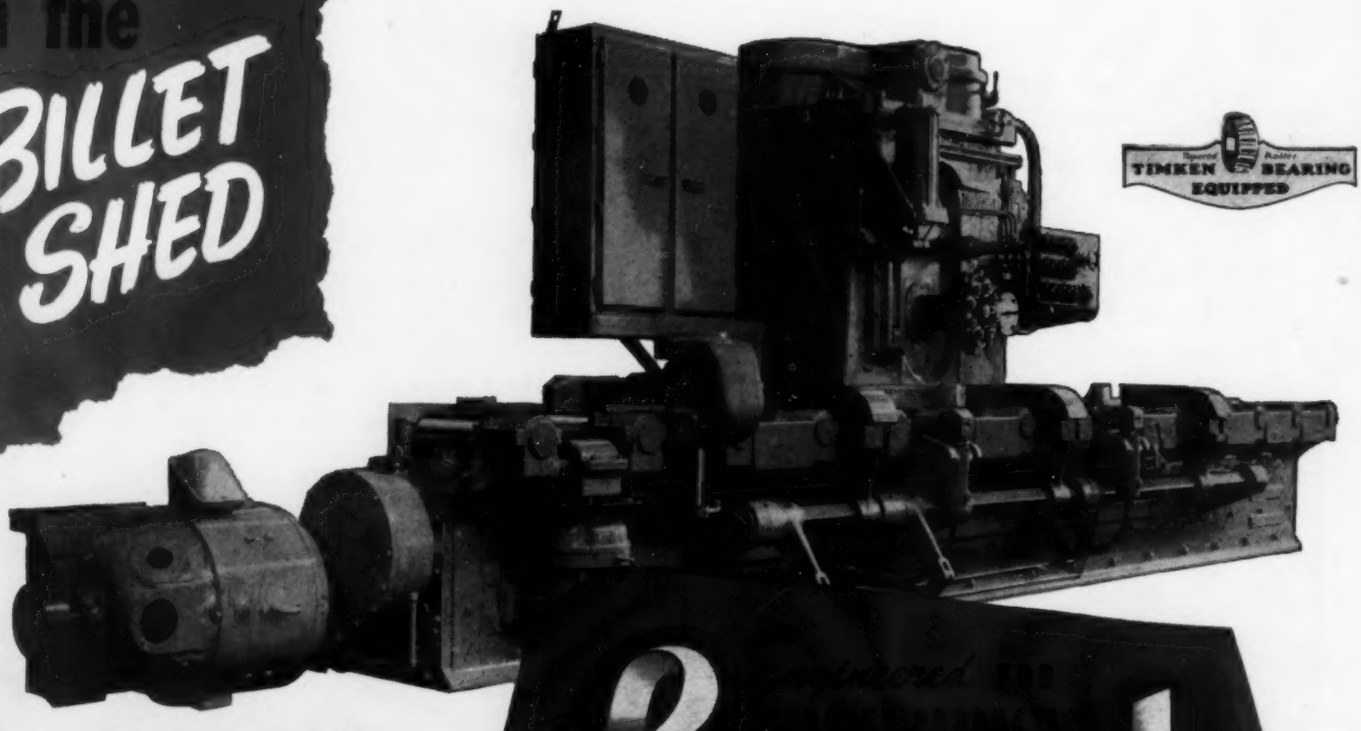
They find the Billeteer never tires . . . never gets groggy or jittery . . . never has "off" days. Production never suffers.

They find the Billeteer saves tons of clean, known-analysis chips ready for remelting.

They find it readily conditions billets which ordinarily would be scrapped because of the prohibitive cost of manual chipping.

They find Bonnot Billeteers, used with the Bonnot Mechanical Inspection Table, completely mechanize the billetshed — and sharply slice conditioning costs.

It will cost you nothing to have the facts. Write.



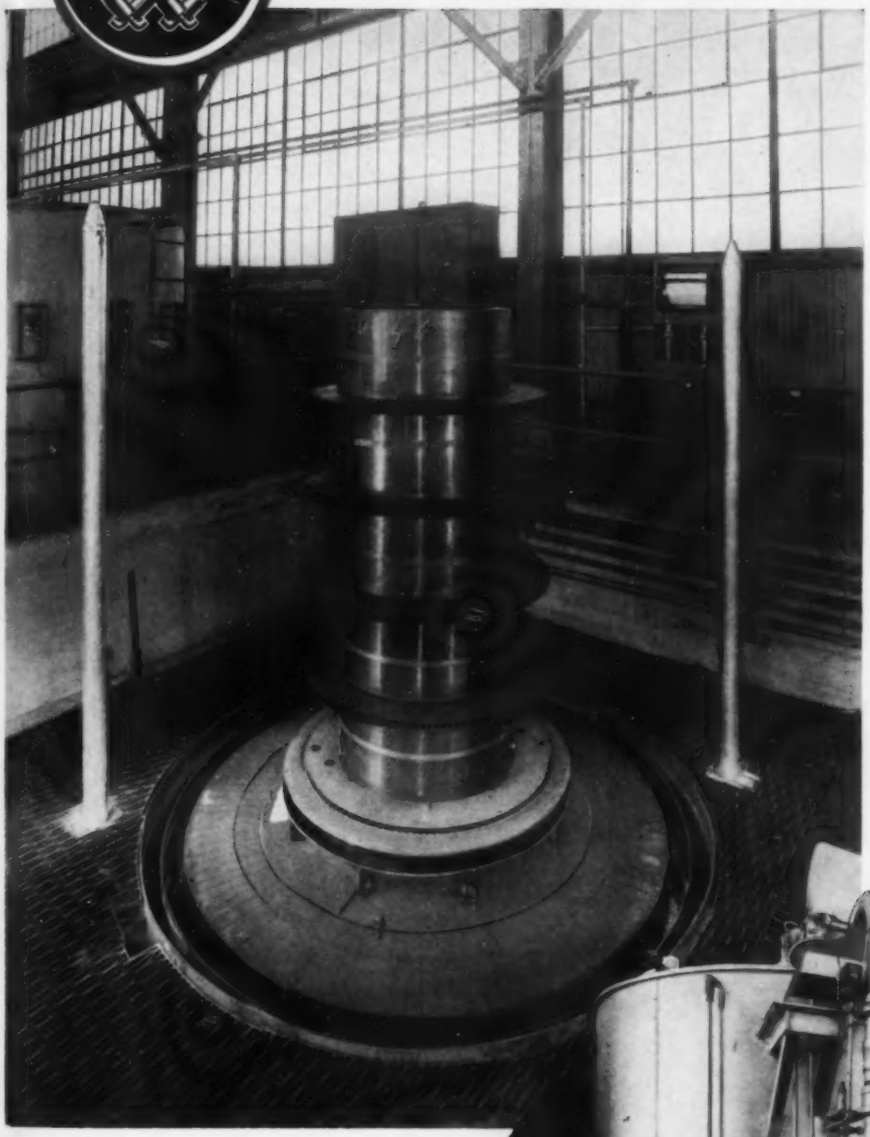
Bonnot

BUILDERS OF THE BILLETEER

For further cost-cutting help, investigate Bonnot Charging Tables, Clay Mixers, Grinding Pans, Clay Feeders, Cold Saws.

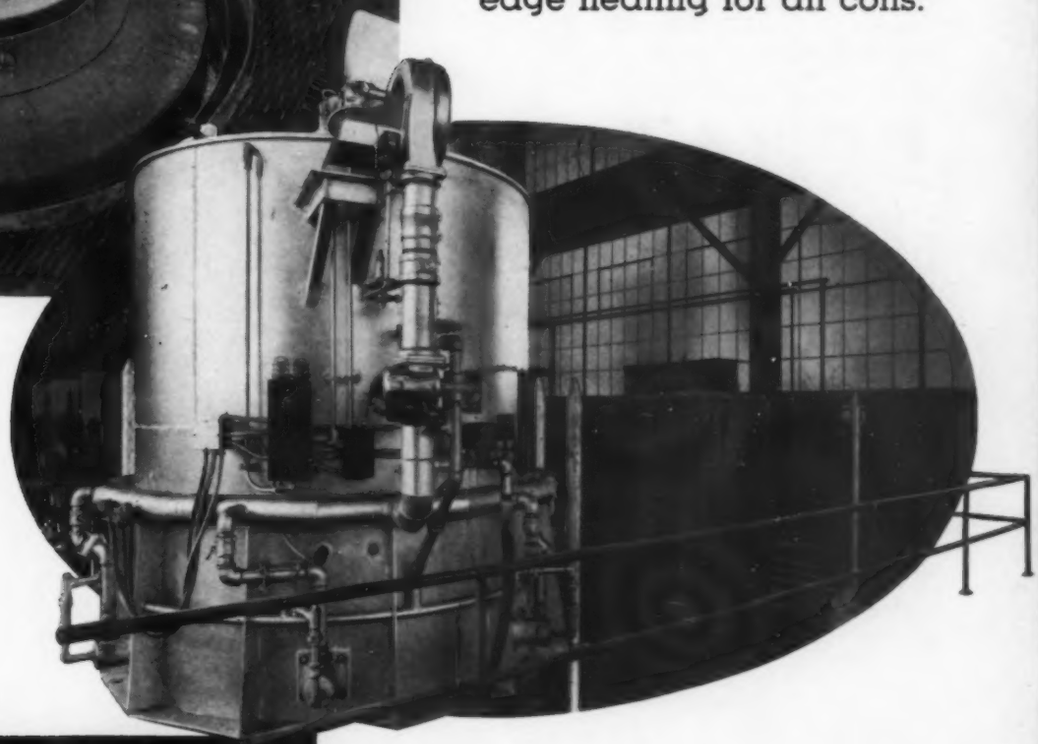
The WILSON RADIANT CONVECTOR FURNACE

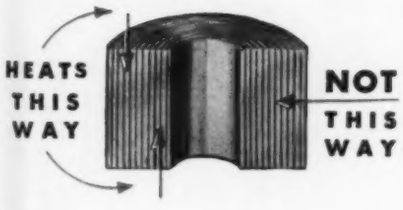
is available in Single Stack Design with Oil Seals for Narrow Strip Mills



This cylindrical bell type furnace installation at Detroit Steel Corporation has a maximum charge size of 48" diameter and 96" piling height.

The charge shown is made up of coils 34" o.d.—12½" wide. A convector between each coil provides edge heating for all coils.





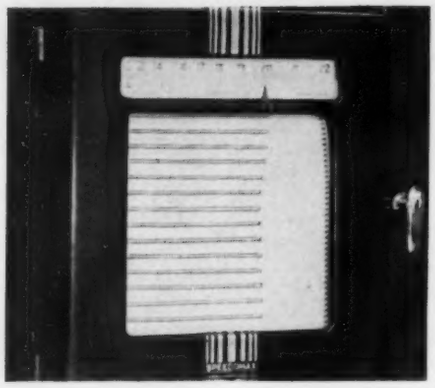
ENGINEERED AND CONSTRUCTED BY THE

Lee Wilson ENGINEERING Co., Inc.

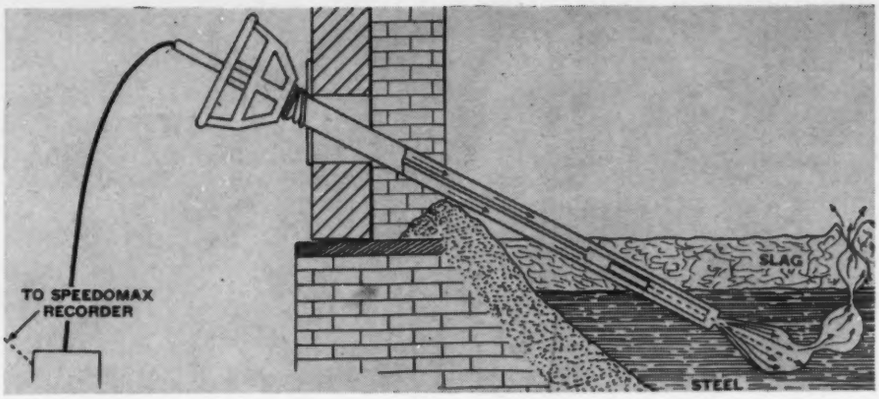
20005 West Lake Road CLEVELAND, OHIO

Telephone ACademy 4670

INDUSTRIAL FURNACES ★ RADIANT TUBE HEATING ★ HEAT TREATING PROCESSES



Speedomax instantly records metal temperature detected by Immersion Rayotube.



Immersion Rayotube in operating position, showing Rayotube sighting directly on the hot metal beneath the slag . . . . measures actual temperature of molten metal.

Operator inserts the tube through the wicket hole, plunges end into the bath. A stream of air blows down the tube, keeps it clear of molten metal and slag.

Actual immersion time is only about 5 seconds. Operator withdraws Immersion Unit, scraping off slag on the edge of the wicket hole, and places instrument on the floor to cool.

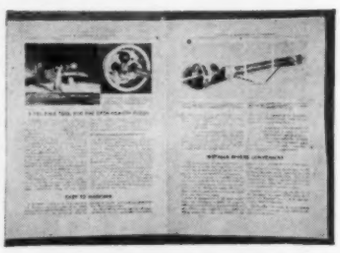
BRAND-NEW INFORMATION

FOR OPEN-HEARTH SHOPS EVERYWHERE

The temperature of open-hearth steel can now be measured repeatedly in the furnace . . . . measured every few minutes, if desired, before tapping instead of afterwards . . . . by means of our Immersion Rayotube Pyrometer.

Metallurgists are getting brand-new information from these measurements — information which helps tremendously in producing the desired analysis in the melt. And this information of course helps in studying the chemistry and physics of steel making.

Open-Hearth Helpers, supplied with this new information, are hitting the tapping temperatures more exactly "on the nose." Correct temperature into the ladle naturally helps to get correct pouring temperature from ladle to mould. Skulls are fewer and smaller, and may be eliminated; overhot pouring is similarly reduced. Thus both better steel and greater operating efficiency can result.



The Immersion Rayotube Pyrometer is dependable, quick and economical. We'll be glad to send Folder N-33B-643(1), on request.

LEEDS & NORTHRUP COMPANY, 4942 STENTON AVE., PHILA. 44, PA.

LEEDS & NORTHRUP

MEASURING INSTRUMENTS · TELEMETERS · AUTOMATIC CONTROLS · HEAT-TREATING FURNACES

Jrl Ad N-33B-643(5)

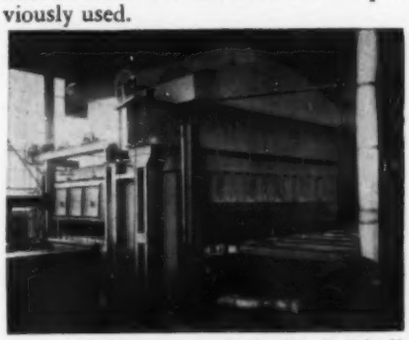
R-S FURNACE FACTS

ISSUED MONTHLY BY R-S PRODUCTS CORPORATION, PHILADELPHIA 44, PA., FOR THOSE CONCERNED WITH QUALITY HEATING OF METALS

Labor-saving R-S Furnaces

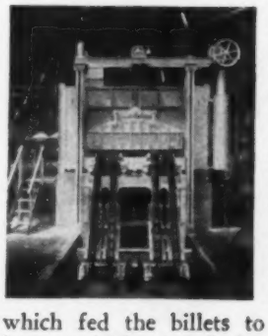
A piece in the paper recently said labor costs are rising. So don't just *order* a furnace! Talk with R-S Engineers and see if we can find a way to do the heating and also save labor costs.

Note the labor-saver below . . . an R-S heat-treating furnace used by Parish Pressed Steel Company for auto truck side frame members. It's a walking-beam type which charges sidewise into 49' 6" heating chambers, discharges endwise through a small side door. Saves labor, saves space! Gives the same production with a smaller furnace than the one previously used.



A historic example is the job R-S built for American Gear and Manufacturing Company (see December 1946 FURNACE FACTS). This 4-unit R-S Furnace ate up automobile axles, steering-knuckles and other hardware as a hen gobbles corn, and put them through a harden-quench-and-draw cycle for the first time by fully mechanized means. Such an operation, now fully automatic, called for manual labor at five points before R-S came up with its revolutionary labor-saving design!

For another example, we show a continuous brass billet heating furnace. It's a beauty, and too bad we haven't room for more pictures of it! The problem here was to get the billets into a furnace raised six feet from the floor. R-S solved it with a storage pit and a heavy self-loading conveyor which fed the billets to the walking-beams which carried them through the furnace. Capacity of 70 billets per hour or 28,000 pounds.



R-S Engineers are constantly at work on problems which combine heat treating with reduction of labor costs and increase of production.

Meet the President!

"Bill" Borbonus is one of the youngest old-timers in the furnace industry. His entire business career has been spent with R-S Products. It was in 1924 that he came from school and set his foot on the bottom rung of the ladder. Three years later he became Purchasing Agent and in 1931 added the title Treasurer. Following several years in sales-work, Bill was elected President in August 1939, proving, to his satisfaction at least, that a rolling stone gathers no moss.

WILLIAM E. "BILL" BORBONUS

However, since 1939 no moss has been gathering on the R-S organization. The old plant at Germantown Avenue and Berkley Street has expanded as far as Apsley Street. Physical expansion of space and equipment has been balanced by the increase in skilled manufacturing personnel and the steady development of the Engineering Department. This has put R-S in a position to execute multi-million dollar contracts, many of which have been handled in recent years.

Bill is now approaching his Silver Anniversary with R-S Products and looking forward to his Golden Anniversary, counting the years between as an opportunity to indulge his hobby of making friends throughout the Metal Industry.

He feels that the future success of the company will rest as its present repute does, securely on the simple policy of sound engineering and conscientious attention to the customer's long-term interest.

A heater named Barney Gilfoyle
Said, "I note that according to Hoyle,
R-S Furnaces use
Any fuel I choose
Whether gas or electric or oil."

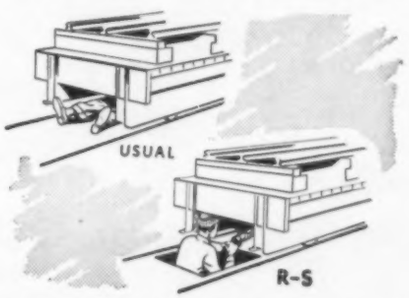
R-S specializes, to be sure, but what we specialize in is Industrial Furnaces, Industrial Heating. We do not specialize in gas, oil, or electricity. We build your furnace to use the most practical fuel.

P-111

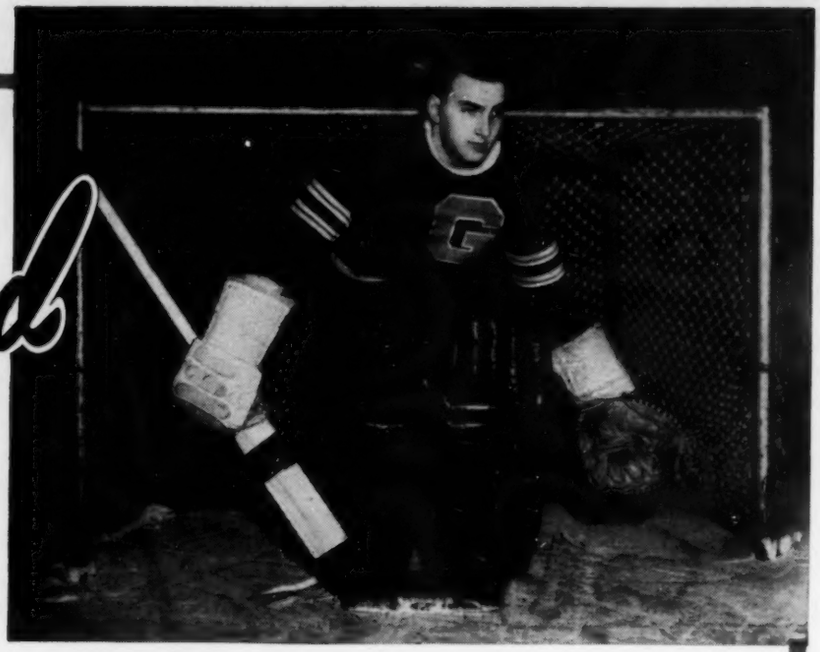
R-S Car Hearth Wheels Get their Grease Without Squeaking

A good furnace designer takes pains to ascertain the standard type of pressure lubricating devices used in the plant where his car-hearth furnace is being installed. He then uses the same type of equipment so that no special tools are required to lubricate the new running gear.

R-S does this, of course, but then we go a step further! R-S plans to make it easy for the workman to lubricate wheels, bearings, and electric motor drive. Unfortunately, most bearings are so placed that the workman has to stand on his head or squeeze into awkward positions to hitch his grease-gun to the lubricating ports. Such inconveniences are an irresistible invitation to neglect. R-S plans a lubricating pit so the workman can work from under the car in full standing position and reach all bearings with a minimum of effort. Result: R-S wheel-bearings and electric motor drive are lubricated when and as they should be . . . all of them . . . and maintenance costs



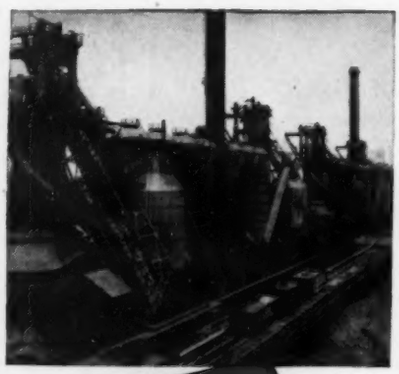
are kept down. It's an important consideration when you realize that 8.2¢ of every revenue dollar goes into maintenance, and it's rising in cost! See 'FURNACE FACTS', January issue.



Prepared to take it!

Gould Plante Batteries are designed to prevent over-expansion and loss of active material.

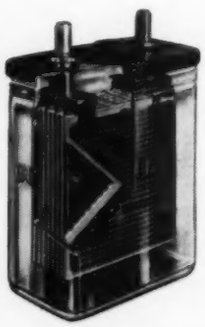
Hockey goalies are prepared for jolts and bruises. Similarly, Gould Plante Batteries are designed to meet all the shocks and strains of the high discharge rates met in standby and control operations. In this service they have out-performed and outlasted all other types of batteries.



and here is the Reason why ...

The two outer negative plates in each Gould Plante Battery are of special construction. They are barricaded with alternate horizontal narrow openings and broad solid sections of heavy lead. This strengthens the entire element against warping and distortion, and effectively prevents over-expansion and loss of useful active material.

For 15 years no adjustments have been made on Plante Batteries because of premature failure. Get the facts. Write Dept. 42 for Catalog 1000 on Gould Sealed-in-Glass Batteries for Stationary Applications.



GOULD
Planté
BATTERIES

GOULD STORAGE BATTERY CORPORATION, Depew, N. Y. Service Centers: Atlanta • Boston • Buffalo • Chicago • Cincinnati • Cleveland Detroit • Kansas City • Los Angeles • New York • Philadelphia • Pittsburgh • St. Louis • St. Paul • San Francisco • Seattle • Zanesville

DOWELL

SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Do your water lines look like this?

Clean water lines quickly, economically, safely the chemical way!

When efficient operation of water lines is the goal—when a full, free flow of water means something in dollars and cents, Dowell's *chemical* cleaning service merits careful consideration.

The modern, tested Dowell method for quickly and safely removing accumulated scale and sludge has proved effective in water lines everywhere—underground—above ground—indoors or out. Dismantling is unnecessary—even small lines complicated by bends, elbows and valves have been restored to designed capacity. The lines are filled through the regular connections with specially selected liquid solvents designed to dissolve and disintegrate the scale and sludge.

Leading railroads, utilities and other industries rely upon Dowell service engineers to perform the entire cleaning operation—bringing with them adequate equipment—special truck-mounted tanks, pumps, mixers, heaters—to control every stage of the successful job. Ask for free booklet—"More Power to America's Industry!" Illustrated in color, it shows how Dowell specialists chemically clean water lines, steam generating equipment, heat-exchangers and many other types of equipment.

DOWELL INCORPORATED • TULSA 3, OKLAHOMA

New York, Philadelphia, Boston, Baltimore, Pittsburgh, Buffalo, Cleveland, Cincinnati, Detroit, Chicago, St. Louis, Kansas City, Wichita, Oklahoma City, Houston, Fort Worth, Shreveport, Mt. Pleasant, Michigan; Salem, Ill.; Borger, Texas; Wichita Falls, Texas; Midland, Texas; Lafayette, La. Long Beach, Casper; Dowell Associate—International Cementers, Inc.

Dowell's industrial engineers are thoroughly experienced in successful chemical cleaning. They are supported by the full research and technical resources of Dowell's own laboratories.

Dowell's field equipment includes the most modern types of scientific devices. Solvents for Dowell chemical scale removal service are mixed especially to fit each individual job.

FREE SHOWING! *New 18-minute sound slide film illustrating the possibilities of Dowell Chemical Scale Removal Service. To arrange a special showing call or write Dowell.*

DOWELL

FOR INDUSTRIAL CHEMICAL SERVICE

1 **Reliable and *narrow band* of control over a wide range of temperature.**

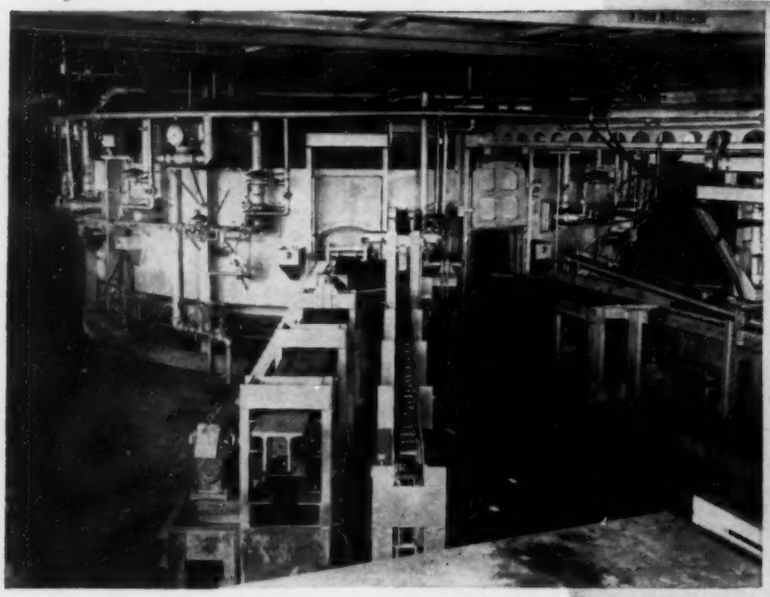
2 ***Accurate* and *foolproof* combustion control for oil or gas.**

3 ***Positive, multiple selection* pressure control.**

4 **Dependable *automatic* material handling.**

Picture of 4 small Salem Rotary Furnaces under construction in 1946.

Get all 4 with Salem Rotary Furnaces



Picture of doughnut type Rotary Furnace and handling mechanism designed and built by Salem in 1946.

Having effected definite savings, increased production, and high quality results for the ferrous field, Salem has proved the adaptability of its large rotary furnaces in the non-ferrous field, too. Salem furnaces are designed with capacities from one ton to over 70 tons per hour to handle and heat the most delicate and sensitive grades of metals. Remember, please, that in addition to effecting low scale losses, low maintenance costs, high quality, and fast production, Salem also shows LOW HANDLING costs resulting from Salem automatic charge and discharge design which requires *one man only!* Let us discuss furnaces with you—write today.

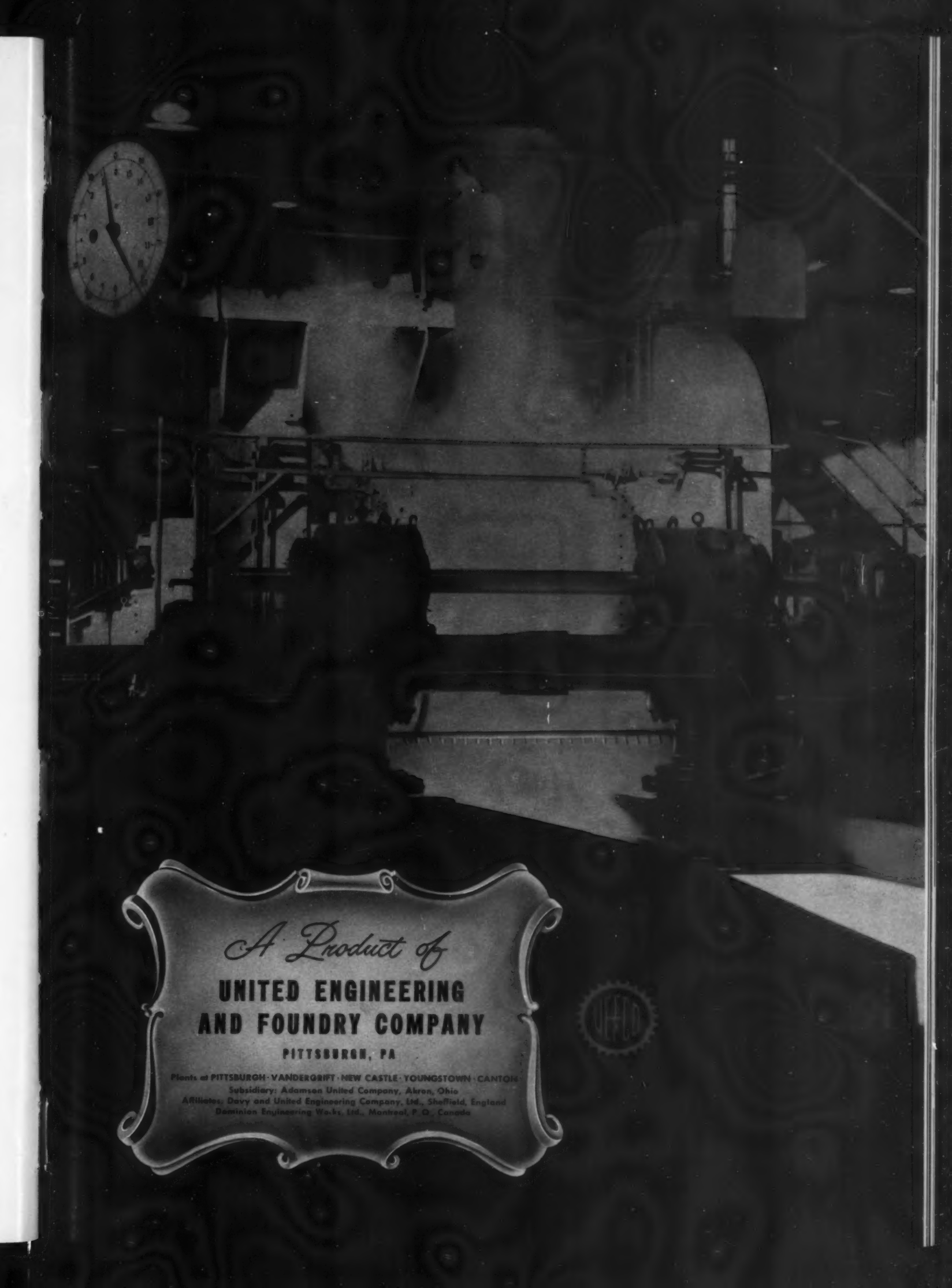
SALEM

SALEM ENGINEERING CO. · SALEM, OHIO

TORONTO, ONTARIO, CANADA LONDON, ENGLAND

Salem Builds

CIRCULAR SOAKING PITS
ROTARY HEARTH FURNACES
CONTINUOUS BUTT-WELD FURNACES
CAR BOTTOM FURNACES
FORGE FURNACES
HEAT TREATING FURNACES
NEEDLE METALLIC RECUPERATORS
AIR RECIRCULATING FURNACES
GAS ATMOSPHERE FURNACES
MECHANICAL EQUIPMENT FOR CHARGING AND DISCHARGING MATERIAL FROM FURNACES



A Product of

UNITED ENGINEERING AND FOUNDRY COMPANY

PITTSBURGH, PA

Plants at PITTSBURGH · VANDERGRIFT · NEW CASTLE · YOUNGSTOWN · CANTON
Subsidiary: Adamson United Company, Akron, Ohio
Affiliates: Davy and United Engineering Company, Ltd., Sheffield, England
Dominion Engineering Works, Ltd., Montreal, P. Q., Canada

SOAKING PIT CONTROLS *by* HAGAN

The objective of soaking pit operation is the maximum production of evenly heated ingots of good surface quality at minimum fuel cost.
Hagan control helps to accomplish this result by:

1. **AUTOMATICALLY** maintaining optimum fuel-air ratio throughout the entire operating range.

2. **AUTOMATICALLY** maintaining the proper furnace pressure at all times.

In addition, Hagan control aids in the attainment of other advantages. In one installation, for example, pits with Hagan control have required no bottom making for more than a year, except for the occasional addition of small amounts of coke. Other pits in the same plant in the same period, have required bottom making as often as once a week.

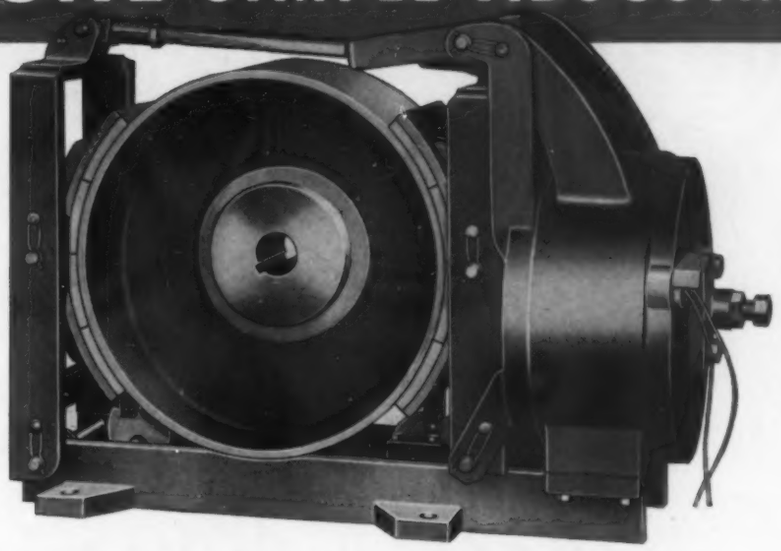
Hagan engineers are thoroughly familiar with steel mill control problems. Their experience is at your service.

HAGAN CORPORATION, HAGAN BUILDING, PITTSBURGH 30, PA.

HAGAN *Automatic* COMBUSTION CONTROL
The pioneer . . . and still the leader

HAGAN
HALL
BUROMIN
CALGON

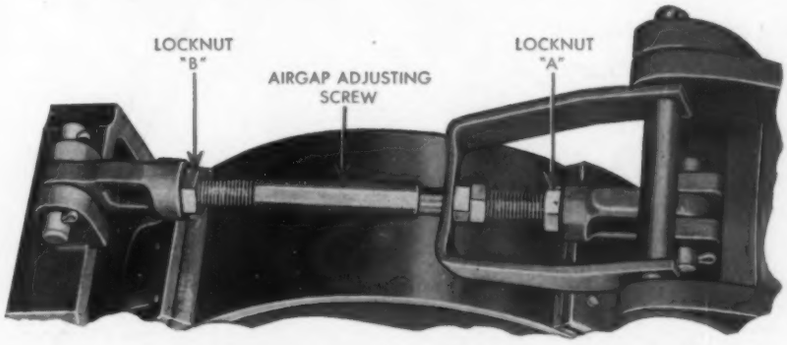
ONLY ONE SIMPLE ADJUSTMENT!



"3C" BULLETIN 106 DC SHOE BRAKE

There's only ONE maintenance adjustment—that's for lining wear. You can see at a glance—DURING OPERATION, OR WHEN THE BRAKE IS IDLE—when lining wear makes adjustment necessary.

Just look at the TOP of the brake—not at the bottom, not at the ends, not at the sides—but on TOP where there's nothing to interfere with examination or correction.



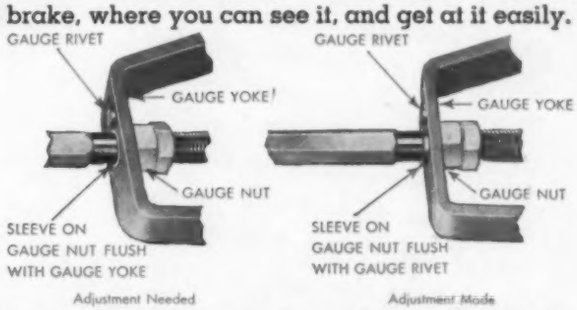
Top view—showing visibility and ease of adjustments

When the sleeve on the gauge unit is flush with the gauge yoke, it means that the lining wear calls for adjustment.

So you loosen locknuts A and B (see picture above). Then you turn the adjusting screw until the gauge nut sleeve is again flush with the gauge rivet (see picture at right). Then tighten locknuts A and B.

That's all! This simple, easy adjustment automatically corrects the Magnet Air Gap and maintains proper shoe clearance.

Shoes cannot tip—shoe drag is automatically eliminated by means of a simple, tamper-proof, patented device. And the entire adjustment is up on TOP of the brake, where you can see it, and get at it easily.



Our nearest District Office or Agency will gladly give you full details. Ask for Descriptive Bulletin 106.

THE CLARK CONTROLLER CO.

EVERYTHING UNDER CONTROL • 1146 EAST 152nd STREET, CLEVELAND 10, OHIO

STEAM PLANTS

FROM BAILEY CONTROLS

1. Get More Steam Per Dollar

Save on fuel
Save on maintenance
Save on power for auxiliaries

2. Deliver Better Power Service

Reduce forced outages
Increase unit capacity
Maintain steam pressure on load swings
Insure adequate process steam
Prevent steam waste

3. Insure Safer Operation

Reduce explosion hazard
Free operators to check any sign of trouble
Prevent excessive steam temperatures
Prevent water carryover and low water
Protect feed pumps at low rates

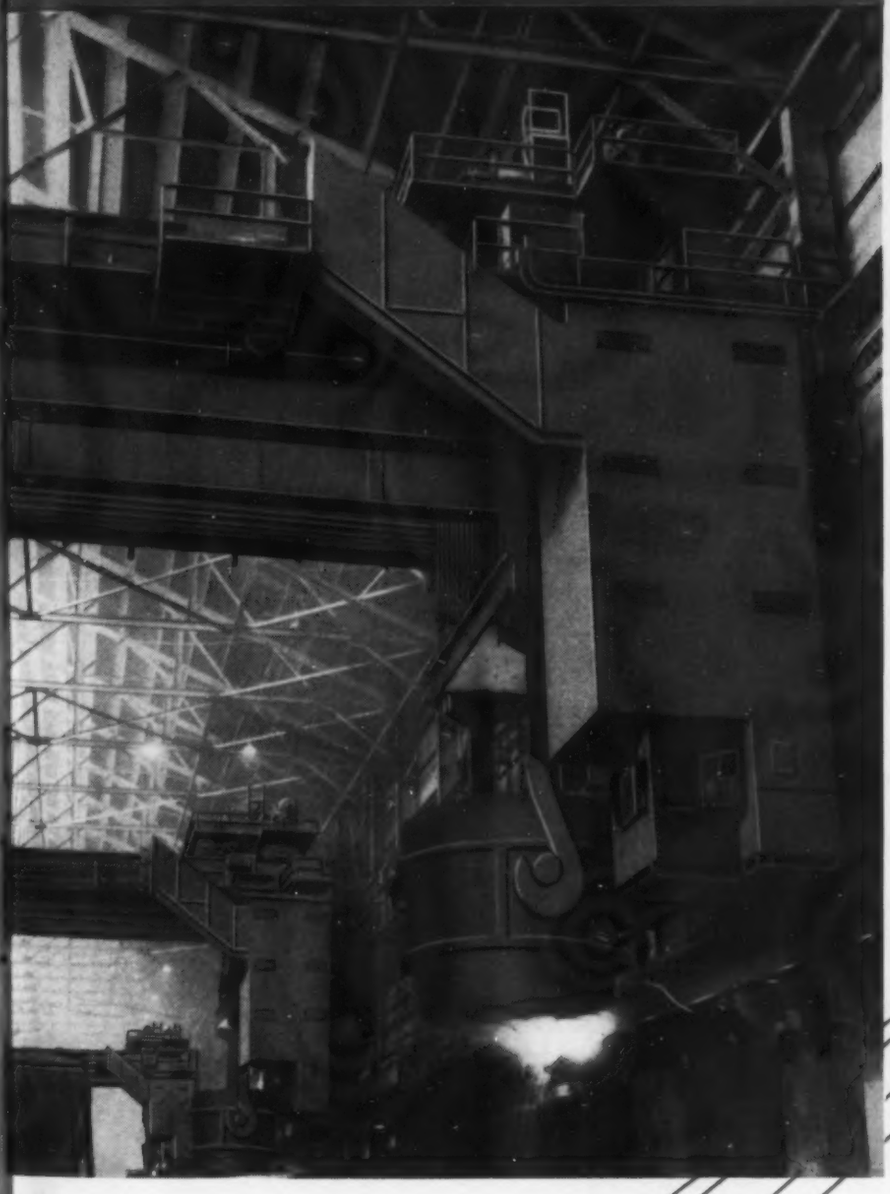
Application to Your Plant

If you would like to have this 3-way profit of money saving, improved power service, and greater safety for your plant, call on your local Bailey Engineer. He will analyze your layout and make recommendations. He is in a position to help you secure the 3-way profit which results from the intelligent use of correctly selected and properly coordinated steam plant controls.

BAILEY METER COMPANY
1047 IVANHOE ROAD • • • CLEVELAND 10, OHIO
Controls for Steam Plants

COMBUSTION • PRESSURE
FEED WATER • LIQUID LEVEL
TEMPERATURE • FEED PUMPS

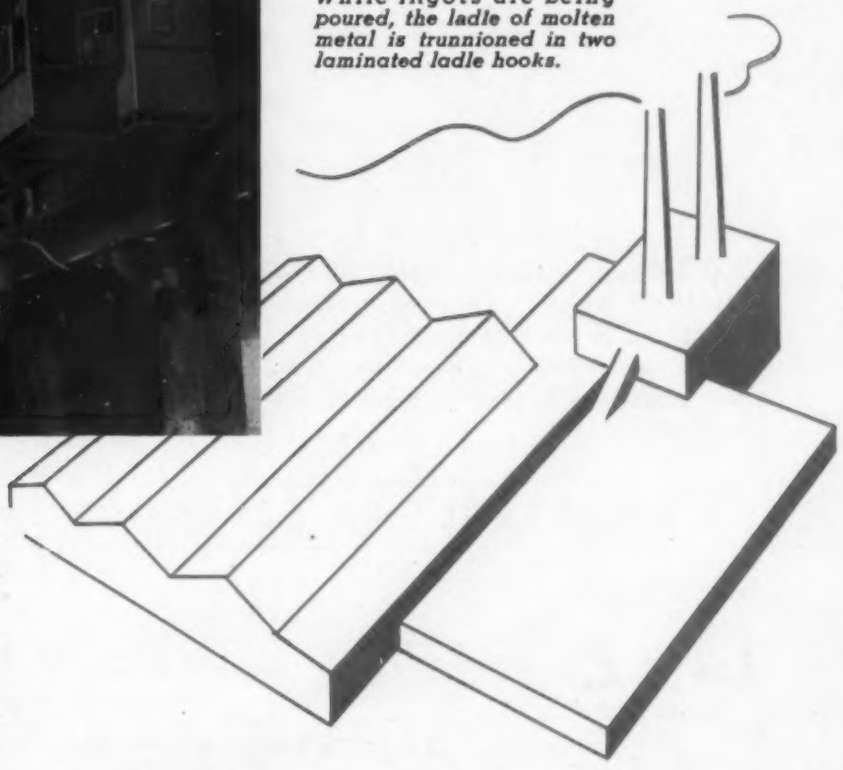
Alliance GIVES YOUR PLANT MORE LIFTING POWER



Alliance builds all types of cranes to convey slabs, ingots, hot metal, raw materials, and finished products safely, quickly, and easily. Shown here is a 275-ton, 4-girder Ladle Crane, equipped with an auxiliary trolley having a 60-ton and a 20-ton hoist. This crane has a safety compartment back of the enclosed operator's cab. The compartment contains a duplicate bridge master control, enabling the operator to move the crane in safety in case hot metal is accidentally spilled. Another safety feature is the enclosed stairway leading from the cab to the footwalk on the crane girder.

For fifty-odd years, Alliance has been known as the World's Largest Builder of the World's Largest Cranes. It always pays to check with Alliance . . . for the development of new cranes or reconversion of old cranes to give your plant more lifting power.

While ingots are being poured, the ladle of molten metal is trunnioned in two laminated ladle hooks.



LADLE CRANES—GANTRY CRANES—FORGING MANIPULATORS—
SOAKING PIT CRANES—OPEN HEARTH CHARGING MACHINES—

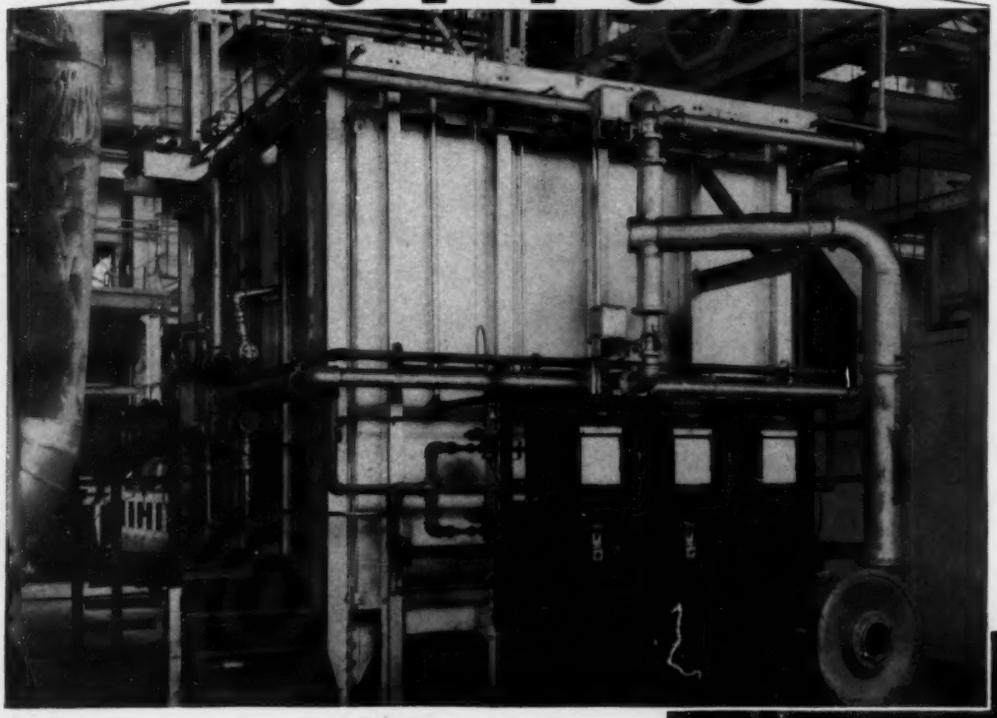
★ *Rely on* **ALLIANCE** *for:*

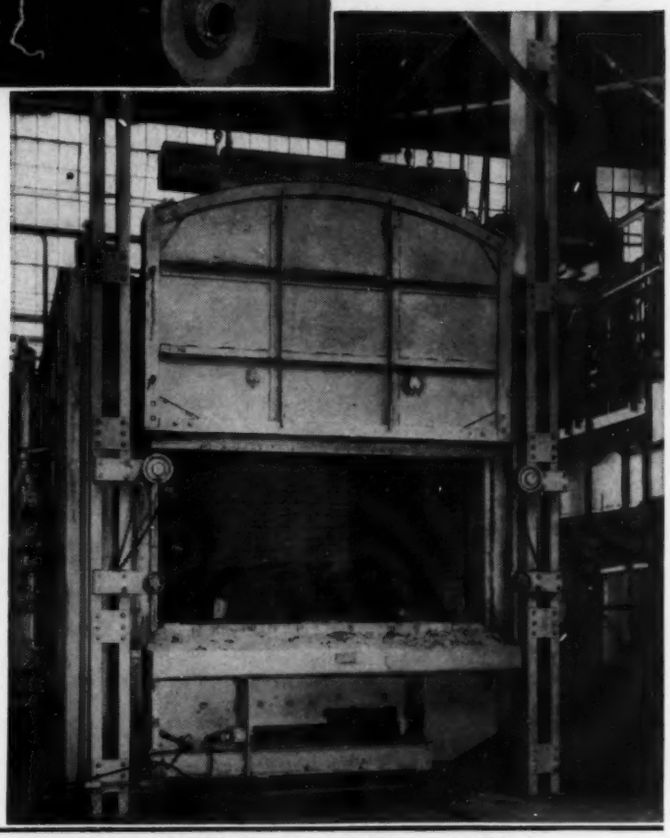
STRIPPER CRANES—SLAB AND BILLET CHARGING MACHINES—
SPECIAL MILL MACHINERY—STRUCTURAL FABRICATION

THE ALLIANCE MACHINE COMPANY

MAIN OFFICE: ALLIANCE, OHIO • PITTSBURGH OFFICE: 1622 OLIVER BUILDING, PITTSBURGH, PA.

LOFTUS





CAR TYPE FURNACES

The Loftus Car Type Furnaces pictured on this page are of the most modern design and construction. Providing for uniform, controlled heat-treating campaigns, Loftus Car Type Furnaces assure high quality annealing for carbon and alloy steels.

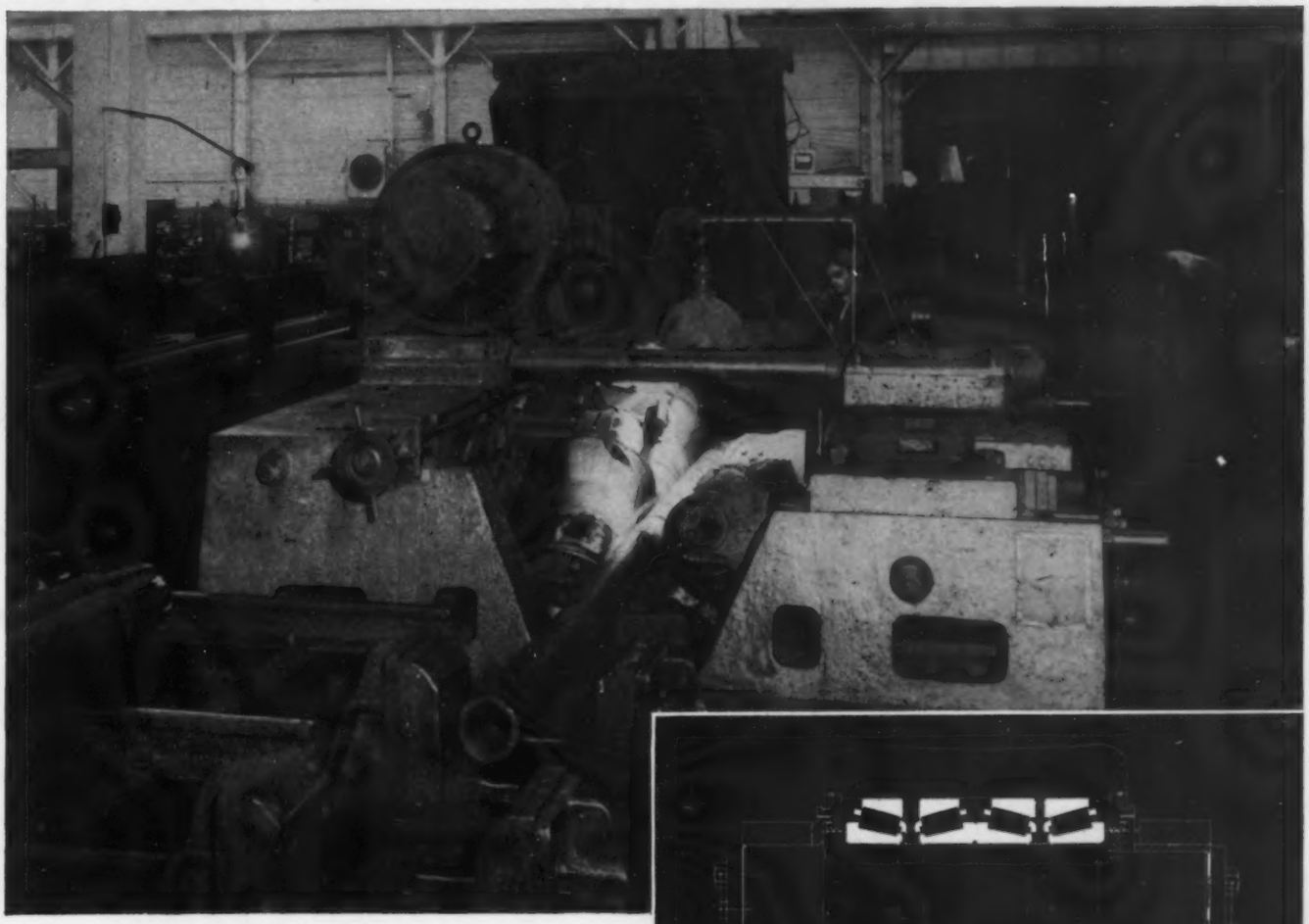
All Loftus industrial furnaces are tailor-made to meet your requirements for economical performance, longer campaigns and greater production. The Loftus Engineering Staff welcomes all inquiries.

A FURNACE FOR EVERY JOB IN THE STEEL MILL

LOFTUS ENGINEERING *corporation*

610 SMITHFIELD STREET PITTSBURGH, PA.
DESIGNERS AND BUILDERS ENGINEERS, CONSULTANTS, CONTRACTORS

TIMKEN BEARINGS CONQUER TERRIFIC PRESSURES



Sutton 3½ BC Round Straightener.

IN SUTTON STRAIGHTENERS

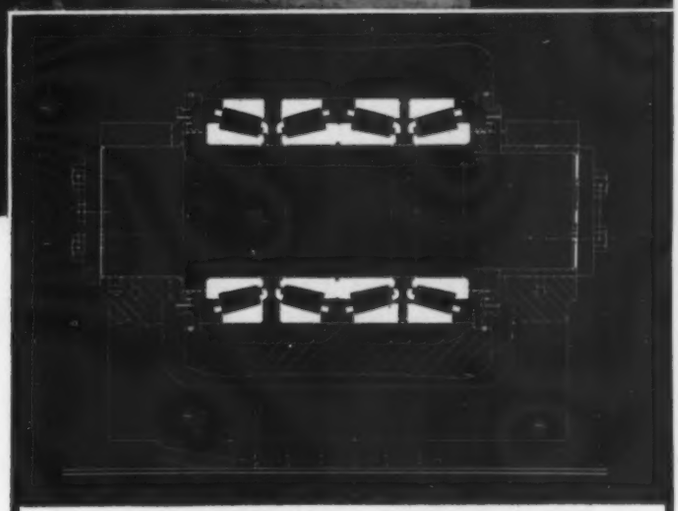
This massive machine is built to take the kinks out of 2″ to 12″ O.D. tubes and 2″ to 8″ diameter bars.

When the tubes or bars hit the rolls, something's going to give — and it isn't the straightener!

Major responsibility for the efficient and constant performance of the machine is carried by the idler rolls, which must continue to turn freely, smoothly and steadily regardless of the terrific pressures imposed on them.

So Sutton Engineering Company mounts the rolls on Timken Tapered Roller Bearings which have proved their capacity to handle the steel industry's heaviest radial, thrust and combined loads in all kinds of equipment — and to do it with maximum dependability, endurance and economy.

Specify "Timken Bearing Equipped" and look for the trade-mark "TIMKEN" on every bearing you use.



Application of Timken Bearings to idler rolls of Sutton straightener.

THE TIMKEN ROLLER BEARING COMPANY, CANTON 6, OHIO

TIMKEN
TRADE-MARK REG. U. S. PAT. OFF.
TAPERED ROLLER BEARINGS

NICKEL HELPS PROVIDE *10 TIMES GREATER SHOCK RESISTANCE* IN MILL BEARINGS

Manufactured by the Bantam Bearing Division of the Torrington Company, races and rollers of the bearing shown above are made of 4 percent Nickel, 1.5 percent chromium steel.

They are carburized to a case depth of ¼" and then hardened in a manner that secures peak load carrying ability and shock-resisting properties inherent in the high-Nickel content steel.

Charpy impact tests show their case hardened areas to have a minimum of 10 times the energy absorption of non-Nickel steels heat treated for the same bearing service.

Hundreds of these bearings, from 10" up to 50" in outer race diameter, have been produced . . . and field reports indicate tonnage records have been considerably increased through use of this tough Nickel alloy steel on jobs where failure would have been costly.

Nickel and its alloys may help to improve your products or equipment. Send us details of your problems for our recommendations. Write today.

INCO Nickel

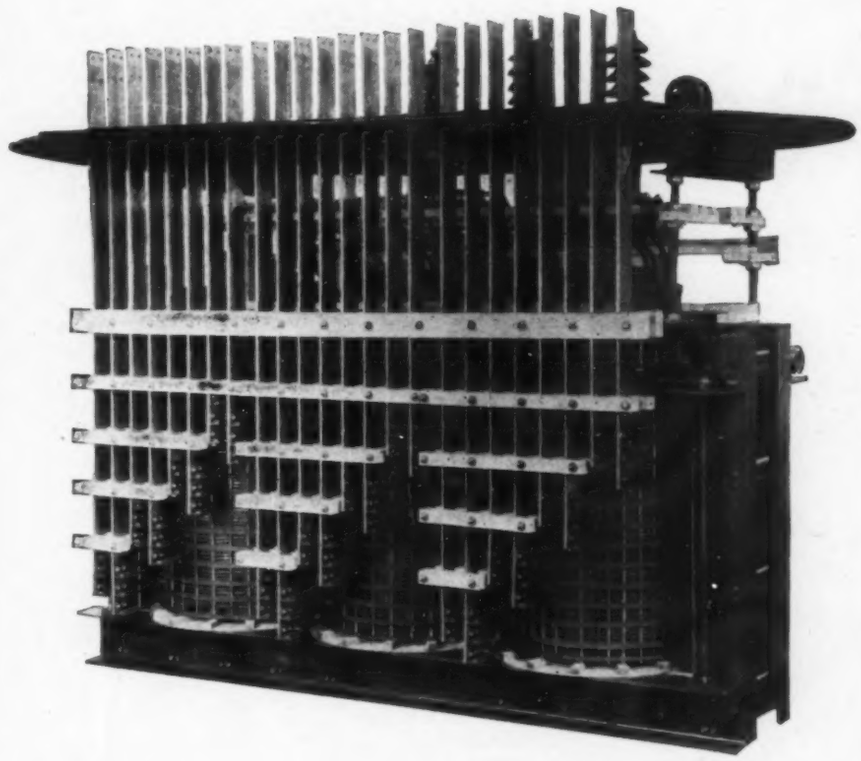
TRADE MARK

Over the years, International Nickel has accumulated a fund of useful information on the selection, fabrication, treatment and performance of alloys containing Nickel. This information and data are yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

FURNACE TRANSFORMER *Facts*

★ The transformer that supplies power to an electric furnace is an extremely complicated unit. The rules governing ordinary designs and construction of Power Transformers do not apply to Furnace Transformers. Many special conditions such as overloads, short circuit stresses, distribution of currents and reduction of eddy losses must be met by engineering skill and highly perfected workmanship.



Pennsylvania Transformer Company has acquired a noted reputation in the Furnace Transformer field. For over thirty years its engineers have closely followed the development of electric furnaces. They fully understand the problems of Electric Furnaces and their relation to Furnace Transformers.

Pennsylvania
TRANSFORMER COMPANY
PITTSBURGH, PENNSYLVANIA

Pennsylvania TRANSFORMERS

1. OVERLOADS & SHORT CIRCUIT STRESSES

Electric Furnace operation inherently subjects Furnace Transformers to frequent short circuits and heavy overloads. The effect of this on the transformer is complicated by the wide range of voltages which necessitates cutting out large portions of the primary windings. The effects of both the radial and axial short circuit forces are greatly reduced in Pennsylvania Furnace Transformers by the use of Circular Coils and an ingenious winding arrangement.

•

2. BALANCING OF STRESSES

Pennsylvania coils are balanced to reduce the radial and axial short circuit stresses to a minimum. 1. The circular shape protects the coils against deformation due to radial short circuit forces. 2. The total axial short circuit force is calculated for each design and the coils are subjected to an equivalent pressure in a three hundred ton hydraulic press. The ability of the coils to maintain their shape, under the prescribed pressure, guarantees that the transformer will safely withstand short circuits.

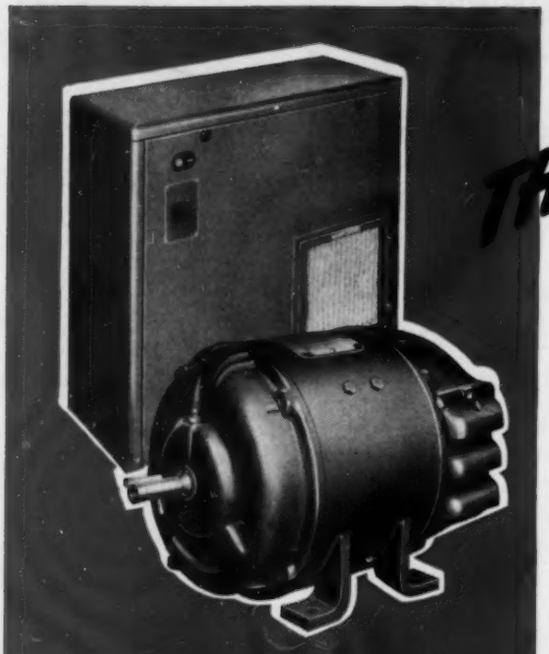
•

3. DISTRIBUTION OF CURRENTS

Due to the heavy secondary currents, the winding must be subdivided into numerous parallel sections. A skillful arrangement of the windings insures that each section carries an equal share of the current. Careful transposition of the individual conductors of each section in the windings reduces the copper eddy losses to a minimum. This results in improved efficiency, more uniform copper temperature and prevention of hot spots.

•

Send your furnace transformer inquiries to Pennsylvania Furnace Transformer Experts.



Conveniently-packaged, space-saving V★S Drives are available from 1 to 200 hp.

THE RIGHT SPEED FOR ANY CONVEYOR

from A-c. Circuits . .

with RELIANCE V★S DRIVE

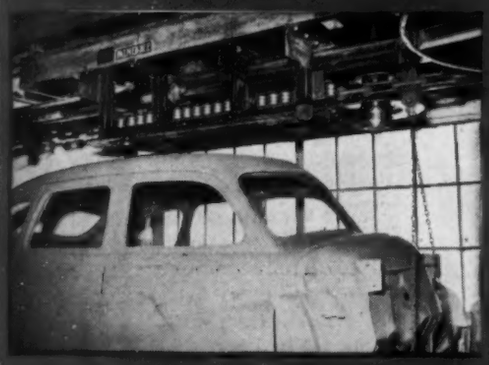
Reliance V★S Drive saves money and makes money in every plant it enters. A good example is the way it increases conveyor efficiency. This *All-electric, Adjustable-speed Drive, operating from A-c. Circuits,* provides the *exact* conveyor speed you want, exactly *when* and *where* you want it. Starting, stopping and reversing can be be gradual or instantaneous, and control may be manual or automatic —from nearby or remote stations.

For information about the many ways in which Reliance V★S Drive can be applied to save and make money, write for Bulletin 311.

RELIANCE ELECTRIC & ENGINEERING CO.

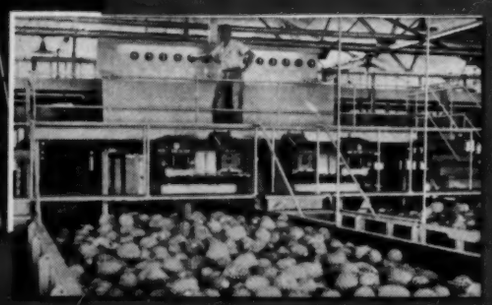
1084 Ivanhoe Road — **Cleveland 10, Ohio**

Appleton, Wis • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Denver • Detroit • Gary Grand Rapids • Greenville, S. C. • Houston • Kansas City • Knoxville • Los Angeles • Milwaukee Minneapolis • New Orleans • New York • Pittsburgh • Portland, Ore. • Rockford St. Louis • Roanoke, Va. • San Francisco • Seattle • Syracuse • Tampa • Tulsa • Washington, D. C. Sao Paulo, Brazil



V★S-equipped conveyors exactly match the speeds of auto bodies and chassis assembly operations.

Modern furniture pieces fast in V★S-equipped conveyors the ideal answer to faster finishing schedules.



Operator of central V★S panel controls 14 feeder-conveyors independently — delivers pineapples to main conveyor as needed.

Reliance Motors, responsive instantly to control-lead V★S controls.

RELIANCE A-C D-C MOTORS

"MOTOR-DRIVE IS MORE THAN POWER"

Power-up for 'round-the-clock schedules

Modern battery-powered trucks will give you all the capacity you need plus safety, every-day dependability and freedom from maintenance. When all the costs are counted, battery-power costs less! The 10% extra capacity, and longer life of Philco "Thirty" Storage Batteries have introduced a new era in low-cost handling. Write for latest catalog of specification data.

PHILCO
STORAGE BATTERIES

PHILCO CORPORATION • STORAGE BATTERY DIVISION • TRENTON 7, NEW JERSEY

Question: What type of electrical cable for all-around service is being widely used in metal-producing and other industries?

Answer: *Okolite-Okoprene* cables, both single conductor and multi-conductor.*

Question: What kind of performance can be expected of Okolite-Okoprene cables?

Answer: *Millions of feet have been installed over the past 20 years and have proved long-lived.*

Question: Where may Okolite-Okoprene cables be installed?

Answer: *In ducts, or buried directly in the ground, or exposed to the elements.*

Question: Is additional protection needed?

Answer: *No.*

Question: What are some of the advantages contributed by the design of Okolite-Okoprene cables?

Answer: *Absence of tapes, braids or metallic coverings that rot or corrode. Perfectly-centered conductors. Uniform thickness of insulation and of covering. Uniform vulcanization throughout entire cable length.*

Question: What are some of the electrical operating advantages of Okolite insulation?

Answer: *High dielectric strength and moisture resistance. Stable characteristics. Low specific inductive capacity. High current carrying capacity. (75°C. copper temperature.)*

Question: What electrical characteristics are contributed by Okoprene, an Okonite-developed neoprene compound?

Answer: *Additional dielectric strength. Additional ozone resistance. High surface resistance which eliminates charging current drainage from cable surface.*

Question: What physical properties of Okoprene provide operating advantages?

Answer: *Lasting weather-resistance. Resistance to oil and solvents. Resistance to acids, alkalies and corrosive chemicals. Non-flammability.*

Question: How about installation?

Answer: *Okolite-Okoprene cables are simple to handle, splice and terminate. They require no potheads. They resist abrasion, are flexible at low temperatures.*

Question: Where can I find out more about Okolite-Okoprene cable and its relation to my problems of electrical distribution?

Answer: *By talking things over with a representative of The Okonite Company, Passaic, New Jersey or writing for Bulletin OK-2009.*

Better Piping . . . the Easier Way
Crane Supplies Everything

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

Ask piping men in any field. They all have the same reasons for standardizing on Crane Equipment. Makes the whole job easier, they say, from design to erection to maintenance work.

Getting everything from one source means simplified specifying and buying. And getting it from Crane assures top quality in all materials for any piping installation.

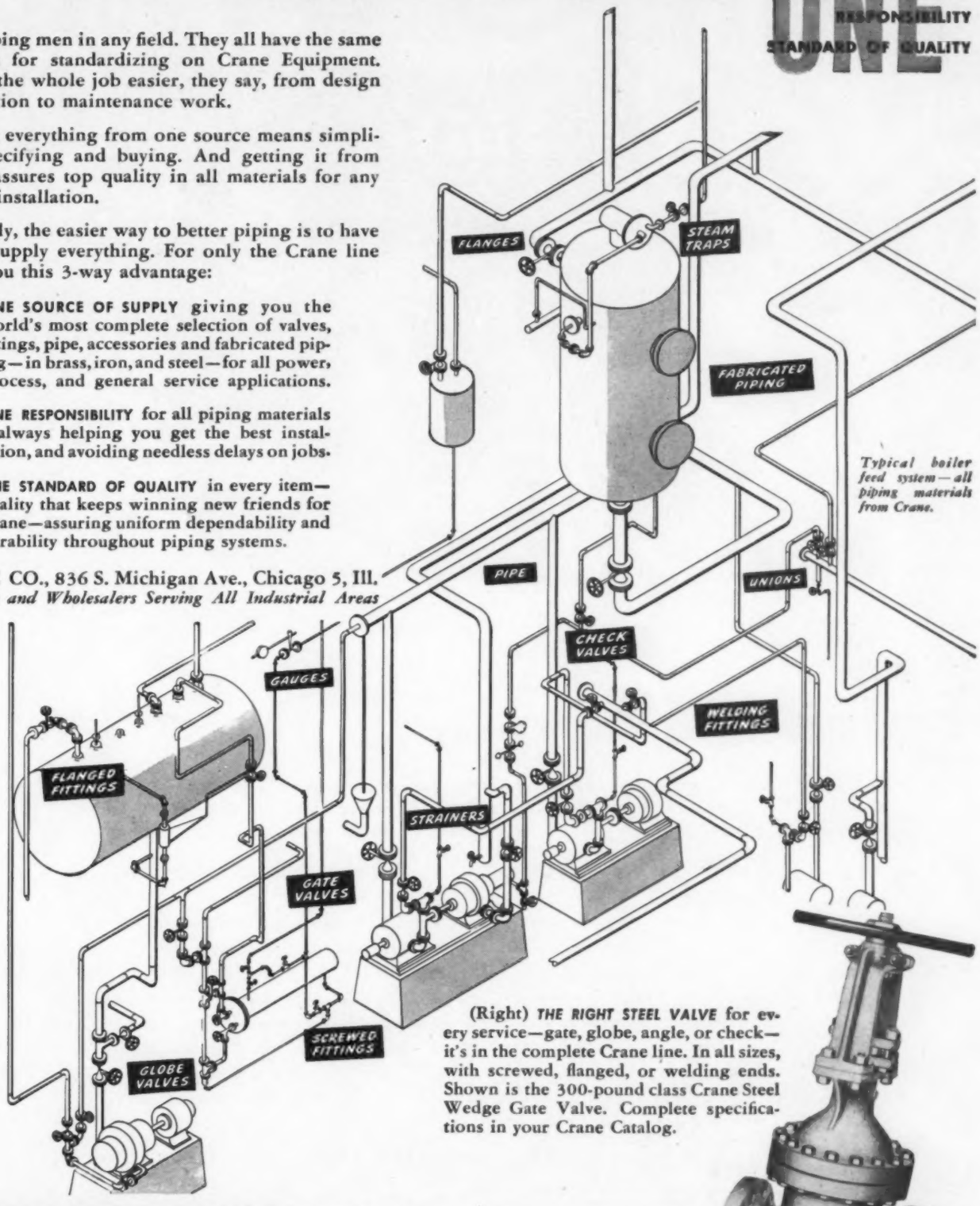
Naturally, the easier way to better piping is to have Crane supply everything. For only the Crane line gives you this 3-way advantage:

ONE SOURCE OF SUPPLY giving you the world's most complete selection of valves, fittings, pipe, accessories and fabricated piping—in brass, iron, and steel—for all power, process, and general service applications.

ONE RESPONSIBILITY for all piping materials—always helping you get the best installation, and avoiding needless delays on jobs.

ONE STANDARD OF QUALITY in every item—quality that keeps winning new friends for Crane—assuring uniform dependability and durability throughout piping systems.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas



Typical boiler feed system—all piping materials from Crane.

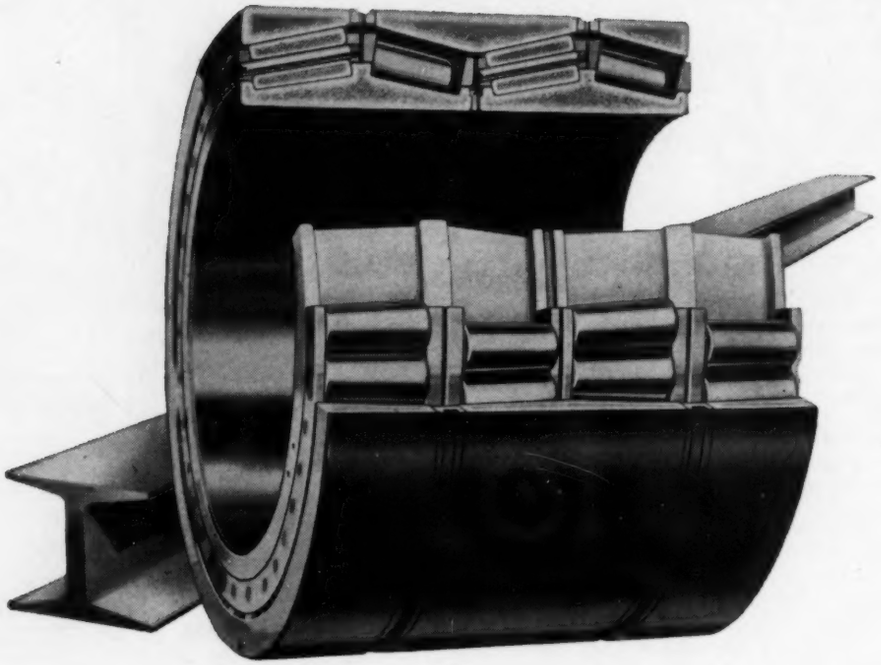
(Right) ***THE RIGHT STEEL VALVE*** for every service—gate, globe, angle, or check—it's in the complete Crane line. In all sizes, with screwed, flanged, or welding ends. Shown is the 300-pound class Crane Steel Wedge Gate Valve. Complete specifications in your Crane Catalog.

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
HEATING • PUMPS

CRANE

FOR EVERY PIPING SYSTEM



Rigidity for heavy loads . . .

is as important in a roll neck bearing as in the finished beam turned out by the rolling mill. Greater rolling mill rigidity can be assured

With Torrington Roll Neck Bearings . . .

to meet today's demand for closer and closer tolerances in the production of plate, strip and structural steel. Maximum capacity and precision operation are secured in Torrington four row *Tapered* Roller Bearings by the use of a maximum number of rollers, positively spaced and guided by pin-type retainers.

The experience of the Torrington Company in designing and building special or standard bearings, large or small, to meet many exacting requirements, is at your disposal. Bring *your* friction problems to our engineers.

THE TORRINGTON COMPANY

SOUTH BEND 21, IND. TORRINGTON, CONN.

Offices in All Principal Cities

TORRINGTON BEARINGS

• NEEDLE • SPHERICAL ROLLER • STRAIGHT ROLLER • TAPERED ROLLER • BALL

Lets take a LOOK at the inside of a WARE HI-LAG Renewable FUSE

Double Fibre Bridge Assembly increases strength 10 times Maintains perfect alignment.
Only one wrench needed to remove blown link and renew.
WARE HI-LAG
250V USE 2 400A
Rugged simplicity. Only 3 parts to handle in renewing link.
GAS VENT HOLES AT BOTH ENDS
HI-LAG Link of one piece, uniform thickness, has large contact areas—wide body areas to insure dependable absorption of heat for time lag.
Arched spring tension washers and heavy studded bolt, keeps links permanently tight. Reducing excessive heat and needless blows.

WARE HI-LAG FUSES have many exclusive features in design and construction which make them far superior in operation—much more economical in rendering longer fuse life and with unsurpassed safety insurance.

Try WARE HI-LAG FUSES NOW! Start enjoying uninterrupted production progress and new fuse economy with the World's Best and Coolest Operating Renewable Fuse.

Write for Brochure giving details of all the COOL FACTS, sizes and prices.

APPROVED BY UNDERWRITERS' LABORATORIES

WARE Brothers 4450 W. LAKE ST. ·· CHICAGO 24, ILL.

WHEN

YOU'RE SEEKING UNIFORMITY OF HEAT TRANSFER OVER LARGE SURFACES

AUTOMATIC—AND PRECISE—CONTROL OF COMBUSTION IS PARAMOUNT

THE USE OF PROTECTIVE ATMOSPHERES NECESSITATES INDIRECT FIRING

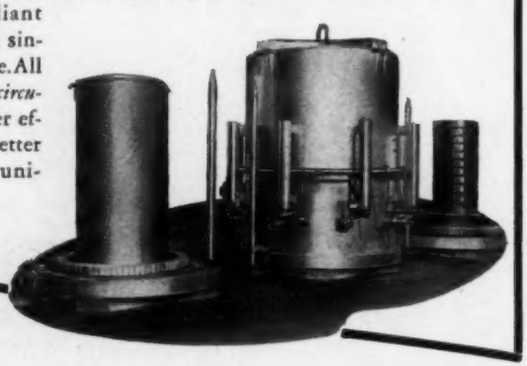
THEN

select a furnace with a KEMP firing system

KEMP-FIRED

ANNEALER BY SWINDELL-DRESSLER

Normal charge — 25 tons of strip in 3 stacks. Used for bright annealing. Extreme specifications on product cover: (1) finish, (2) grain size, and (3) ability to be deep-drawn. Loading space under inner cover – 6'6" dia. by 8' high. Heated by *vertical* KEMP radiators (radiant tubes) — plus a single *horizontal* one. All radiators are *recirculating* for higher efficiencies and better temperature uniformities.



The best furnace builders use the best firing systems—because they know that *better control over combustion characteristics and heat transfer patterns makes for better control over heat treating results.*

KEMP firing systems hold top spot in the quality parade because: (1) KEMP carburetors can maintain gas-air ratios more accurately, more automatically and more reliably than other fuel mixing methods, (2) KEMP systems can operate at higher burner pressures (even above 5 psi, if you wish) to provide wider control ranges and higher furnace capacities, and (3) KEMP burners can be engineered to the shape, zoning, intensity and mode of heat transfer desired.

Building furnaces is *not* KEMP's business—but building their carburetion-and-combustion systems *is* KEMP's business. Make sure your next furnace installation is KEMP-fired.

KEMP OF BALTIMORE

PRECISION CARBURETION +

ADAPTED COMBUSTION FOR INDUSTRY'S HEAT USING PROCESSES

ATMOSPHERE GENERATION & ADSORPTIVE DRYER SYSTEMS FOR PROCESS CONTROL AND PROTECTION

JML Co.–KM1

The C. M. Kemp Mfg. Co.
405 E. Oliver St., Baltimore 2, Md.

Send me literature on your Series-S carburetors and firing systems.

NAME .....

POSITION .....

COMPANY .....

PLACE .....

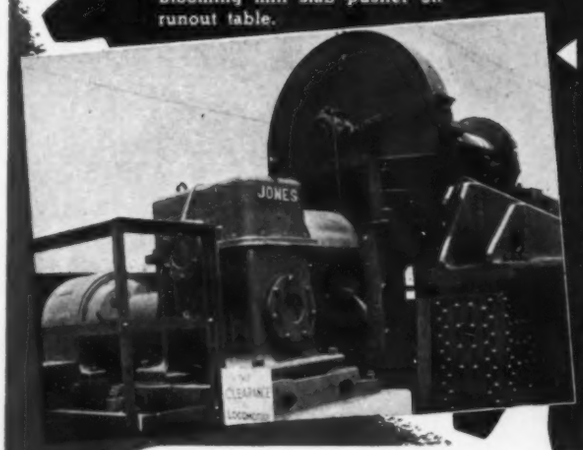
Our furnaces are built by .....

.....

JONES DRIVES
in the Steel Industry

Jones double reduction Herringbone Reducer driving blooming mill slab pusher on runout table.

Carriage travel for cold strip processor driven by Jones worm gear.



Jones worm gear driving blooming mill crop conveyor.

Jones triple reduction Herringbone Reducer driving blooming mill shear approach table — adjustable side guards.

• There are many sound reasons why Jones Herringbone and Worm Gear Reducers have been selected for these and many other applications in the steel industry . . . reasons which we believe you will also find sound and convincing when you are considering your drive problems. In any case we shall be pleased to place complete information in your hands covering speed reducers and other Jones transmission products.

Jones

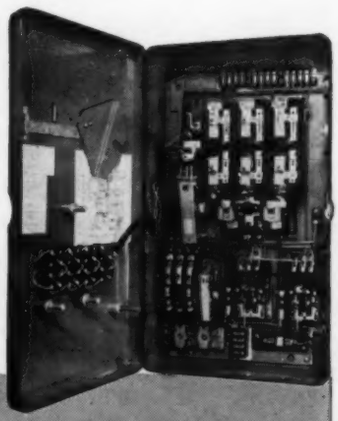
HERRINGBONE • WORM • SPUR • GEAR SPEED REDUCERS • PULLEYS • GEARS • V-BELT SHEAVES • ANTI-FRICTION PILLOW BLOCKS • FRICTION CLUTCHES • FLEXIBLE COUPLINGS

W. A. JONES FOUNDRY & MACHINE CO., 44[illegible] ROOSEVELT ROAD, CHICAGO 24, ILLINOIS

"If you could come with me to the special assembly division at Plainville, you'd see what I mean. The day we took these pictures, for example, there was a multi-motor controller for a famous machine tool manufacturer, individual plug-in type control center units for a large oil refinery, the complicated fully automatic 'electric brain' for a paper making machine — all being manufactured on a standard production basis — *specials* in every sense of the word — but made from tried and proved Trumbull Electric basic components. Such basic components mean to you, as the customer, special controls with *standard* Trumbull performance.

"Standard design elements in the tremendously varied Trumbull production range make it possible for our customers' design engineers to specify special controls without running into a stone wall of excessive *special costs.*

"Of course, we of Trumbull can only try to give you a quick picture of a mighty good proposition in these few words. If you have a problem that indicates modern electrical control, it will be well worth your while to write now or come to our Plant and see for yourself. Trumbull engineers are good people to talk to — and work with."



TRUMBULL (T) ELECTRIC

MOTOR CONTROL

THE TRUMBULL ELECTRIC MANUFACTURING CO.
PLAINVILLE, CONNECTICUT
OTHER FACTORIES AT NORWOOD, OHIO • LOS ANGELES • SAN FRANCISCO • SEATTLE

Continental

designers and builders of Dependable

Plate Mill Equipment

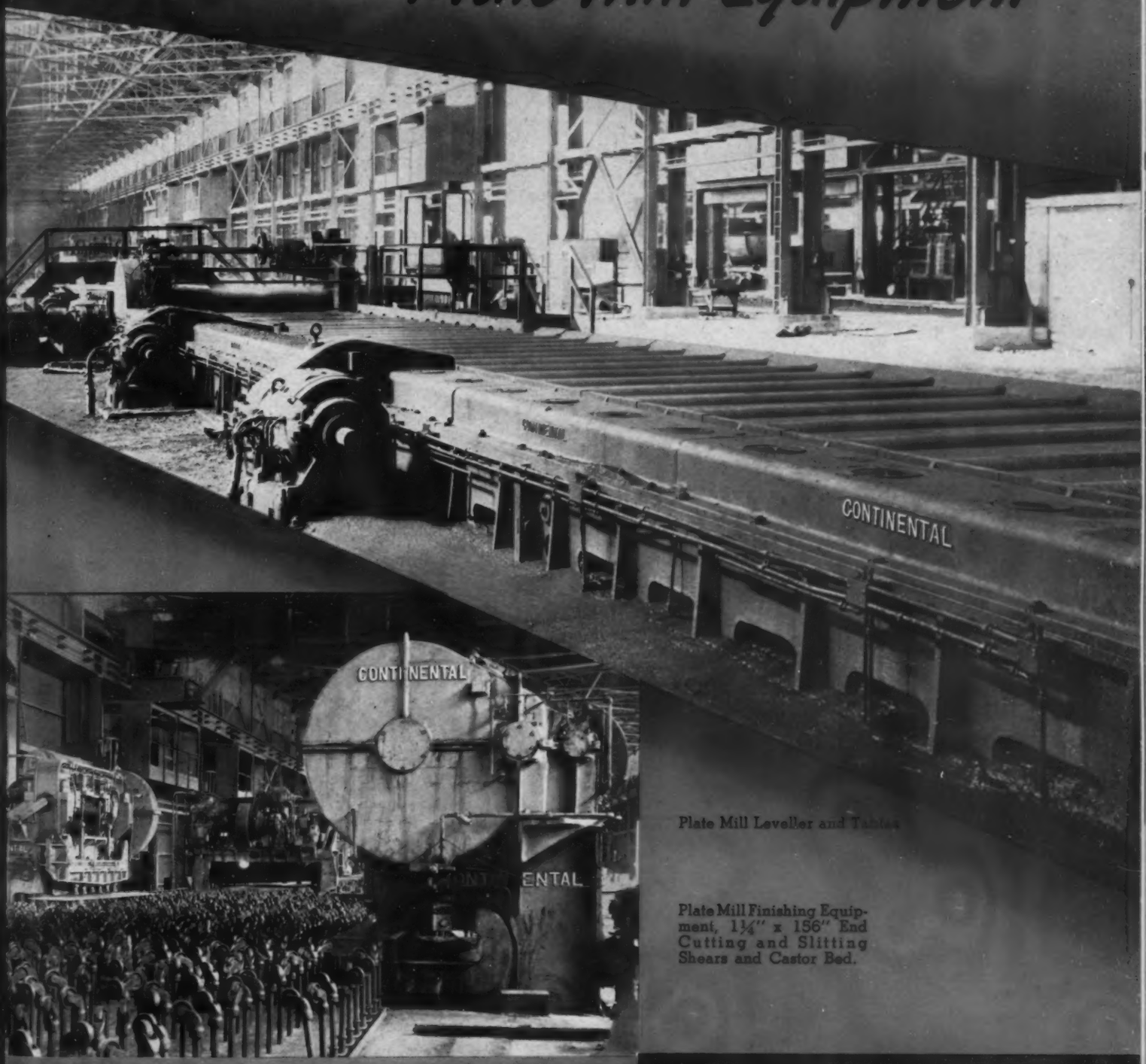


Plate Mill Leveller and Tables

Plate Mill Finishing Equipment, 1¼" x 156" End Cutting and Slitting Shears and Castor Bed.

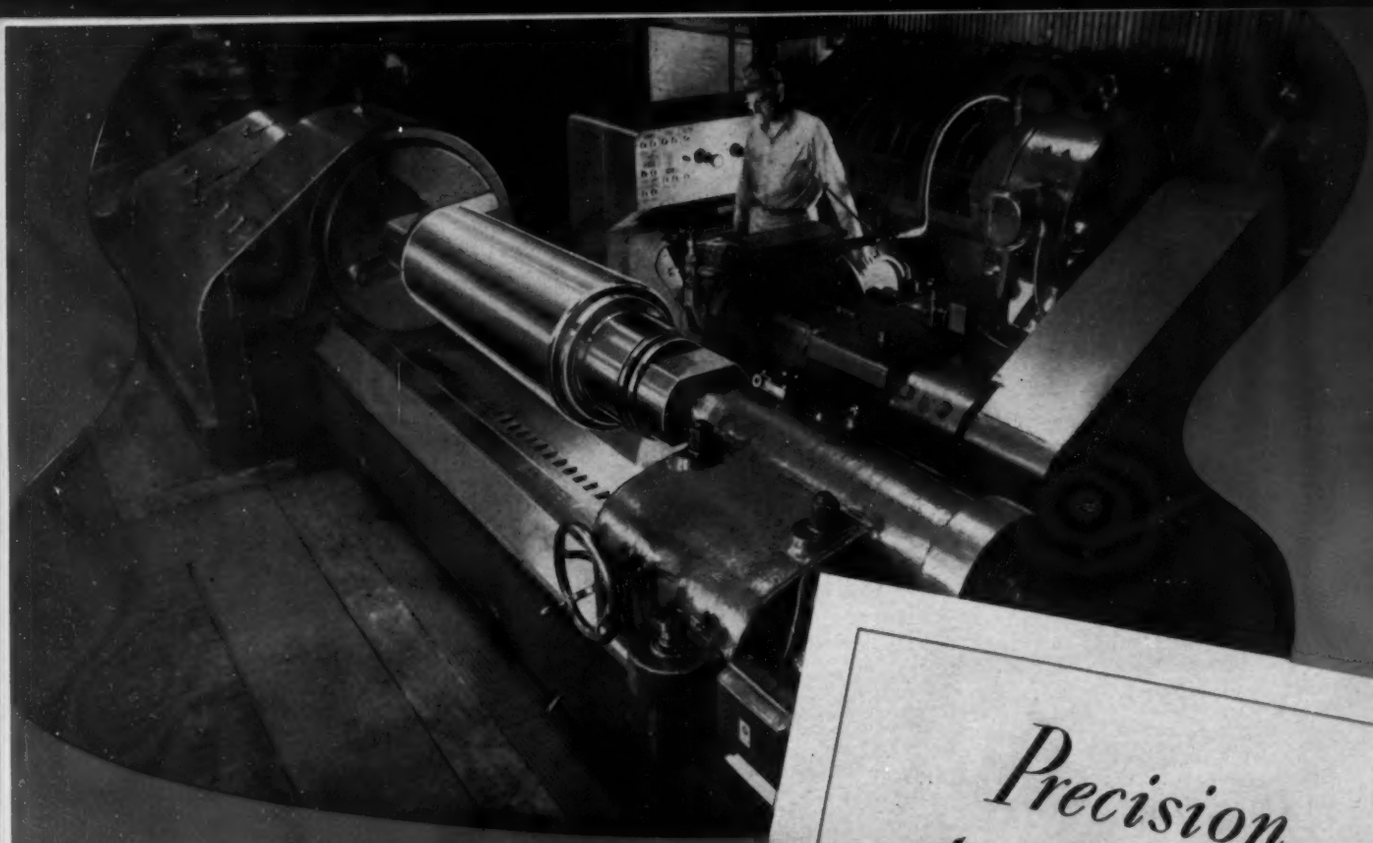
"Continental-built" is an important phrase to every ferrous and non-ferrous metal producer. It means advanced engineering and intimate experience with the difficult problems in designing and building dependable, *profit-producing* equipment. Continental is ready *now* to help you on *any* equipment problem.

Continental

FOUNDRY & MACHINE CO.

CHICAGO • PITTSBURGH

Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.



Precision at work . . . .

on

Continental

ROLLS

With the skilled craftsmanship of long experience and modern high precision equipment CONTINENTAL produces the exact physical and service characteristics you require in ROLLS.

To assure economical, high tonnage roll life for every rolling operation . . . check *first* with CONTINENTAL.

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Industry's headquarters for Iron and Steel Rolls, Rolling Mills and Equipment, Carbon and Alloy Steel Castings

Experience points to

Bliss for rolling mills

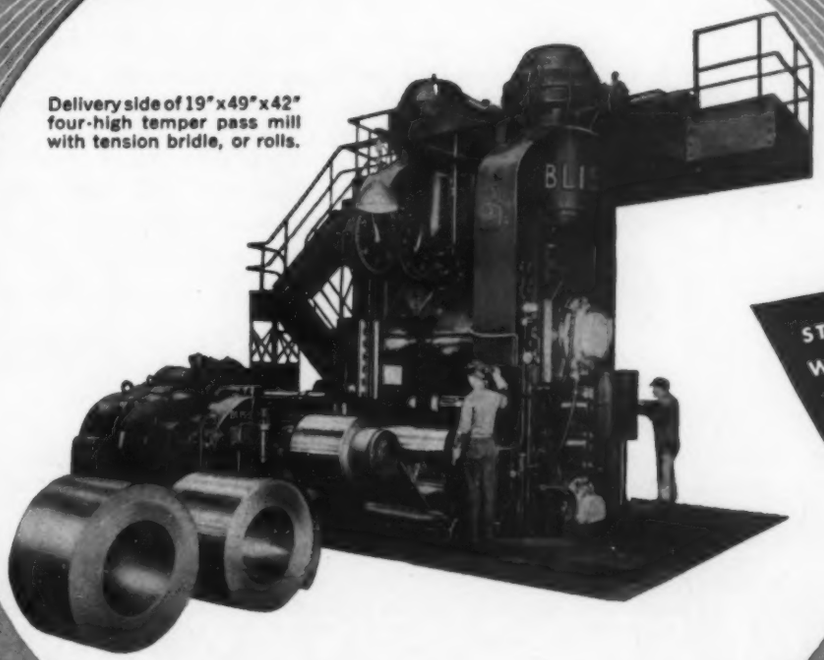
Hundreds of outstanding Bliss sheet and strip mill installations—here and abroad—give daily evidence of the close cooperation between customer and builder which alone can create a mill exactly suited to the job at hand.

Whether your requirements concern 2, 3, 4-high or cluster mills; hot- or cold-rolling of ferrous or non-ferrous metals, Bliss can supply the equipment specially designed to suit your needs. In addition, Bliss builds an extensive variety of accessories: mandrel type hot mill coilers, upcoilers, slitters, reels, etc.

Call on Bliss for the best in rolling mill machinery. Your inquiry will receive prompt attention and constructive follow-through.

E. W. BLISS COMPANY Rolling Mill Division
Salem, Ohio

ROLLING MILLS, MECHANICAL AND HYDRAULIC PRESSES,
CAN AND CONTAINER MACHINERY



Delivery side of 19"x49"x42" four-high temper pass mill with tension bridle, or rolls.

STAY AHEAD WITH *Bliss*

THIRTEEN TIMES THE LIFE AND STILL NO WEAR!

WITH "TOOL STEEL PROCESS" SPROCKETS

It's the tonnage that counts! And you can get your tonnage more profitably with "Tool Steel" sprockets.

Steel men everywhere attest to the fact that "Tool Steel" sprockets provide many, many times the service life of ordinary sprockets. The costs are comparable but your investment in "Tool Steel" means real profits.

We carry a complete line of "Tool Steel" sprockets for immediate delivery. Drop us a note today.

GEARS • PINIONS • SPROCKETS • WHEELS
and other TOOL STEEL HARDENED PRODUCTS

"Tool Steel" cut tooth sprocket, on a double rack drawing machine, has furnished 9 years of continuous service life without wear. In the same service, untreated steel sprockets were worn out within 8 months. Such records of superiority are commonplace with "Tool Steel".

THE TOOL STEEL GEAR & PINION CO.
CINCINNATI 16, OHIO

SERVICE TO STEEL MILLS by LINK-BELT

Complete line of Chains for transfer tables, coil conveyors, furnace conveyors, feeder and catcher tables, sheet pilers, draw bench and other equipment . . . Elevators and Conveyors of all types, such as belt, bucket, screw, flight, Bulk-Flo, drag chain, apron, Sidekar-Karrier, trolley, Oscillating-Trough, etc. . . . Vibrating Screens . . . Dryers and Coolers . . . Skip Hoists . . . Car Dumpers . . Car Spotters and Haulage Systems . . . Portable Conveyors and Bucket Loaders . . . Traveling Water-Intake Screens . . . Automatic Stokers . . . Silent and Roller Chain Drives . . . Speed Reducers and Increasers . . . Variable Speed Transmissions . . . Sprockets . . . Gears . . . Clutches . . . Couplings . . . Babbitted, Ball and Roller Bearings, etc.

LINK-BELT CONVEYORS MOVE coils smoothly . . .

Link-Belt conveyors are especially designed to move and transfer coils smoothly — and without edge damage. While built in a variety of designs for specific production problems — the basic thought in ALL designs is the reduction of scrap losses due to strip damage.

Ample bearing surfaces carry the coils smoothly — without telescoping. Rugged construction, conforming to steel mill requirements, eliminates delay and allows low operating costs.

Mill equipment by Link-Belt means a complete Link-Belt service... design, manufacture and installation. As pioneers in the development of materials handling in the steel industry, you can look to Link-Belt for practical, proven cost-reducing mechanization.

LINK-BELT COMPANY

Chicago 9, Pittsburgh 19, Cleveland 13, Detroit 4, Indianapolis 6, St. Louis 1, Kansas City 6, Mo., Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities.

10,252

LINK BELT CONVEYORS

PREPARATION EQUIPMENT . . . POWER TRANSMISSION MACHINERY

SERIES 600

DIAPHRAGM AIR MOTORS

Furnished as one unit — complete with North American Adjustable Port Valves.

Used with pneumatic type instruments for throttling control of air, gas, oil, water or steam.

by NORTH AMERICAN

For Combustion

THE NORTH AMERICAN MFG. CO.

GAS OR OIL COMBUSTION EQUIPMENT • BRANCH OFFICES IN PRINCIPAL CITIES

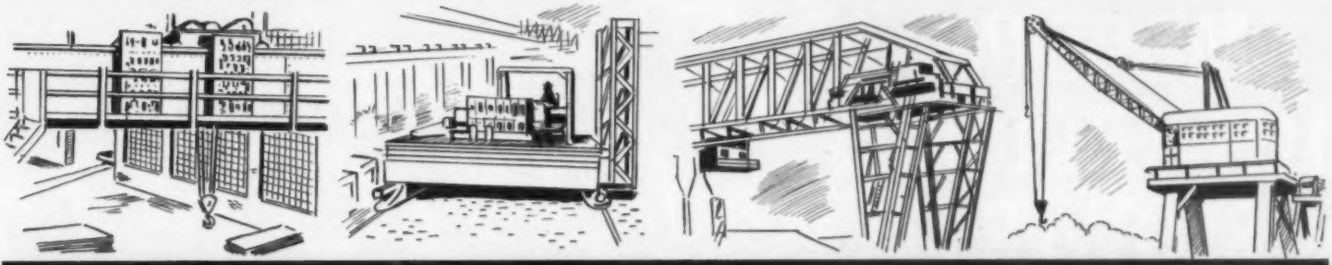
CLEVELAND 5, OHIO

Adjustable Port Fuel Valve and Motor

Butterfly Air Valve and Motor

Adjustable Port Air Valve and Motor

OVERHEAD CHARGER ORE BRIDGE PORTAL



EVERYTHING UNDER CONTROL

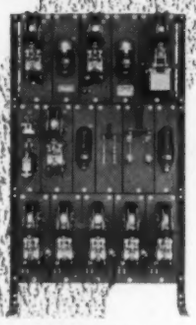
FOR DIRECT CURRENT CRANES

For many years, EC&M has led in the development of extremely sturdy, highly efficient electrical equipment for cranes . . . equipment that meets the requirements of good cranes.

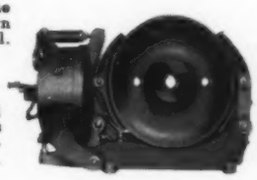
EC&M engineers have designed into this equipment that extra margin of safety and quality which insures uninterrupted service . . . which also includes features appreciated by maintenance men and operators as aids in their daily tasks.

Many users recognize the symbol, EC&M, as a standard of value and specify this equipment whenever new cranes are purchased or when revamping existing installations. These users know that control, only a small part of the initial cost, is a vital part of every crane.

They know, too, by experience, it pays to standardize on EC&M Control for cranes.



Moving loads at high speed and spotting loads accurately are two of the many advantages of EC&M Magnetic Control which appeal to crane operators and help them turn out work promptly. Bulletin 921.

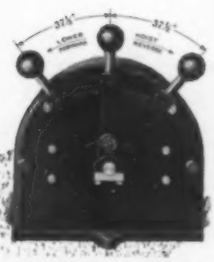


To stop and hold the load, E&CM Brakes are quick-releasing, fast-setting and long-lived. Bulletin 1004.

To prevent overhoisting, enabling the operator to do better work by removing the fear of an accident from his mind—Youngstown Safety Limit Stops. Bulletin 1032.

To protect cranes, this single unit Protective Panel contains overload relays, knife switch and push-button-operated main line contactors. These units provide low voltage protection to the entire crane and permit disconnecting power to all motors in an emergency. Bulletin 1021.

For disconnecting power when leaving the crane—an EC&M Disconnect Switch of the manual-magnetic type for easy opening or closing of the circuit to the main collector-bars. It reduces replacement-part problem since parts are associated with magnetic control. Bulletin 1024.



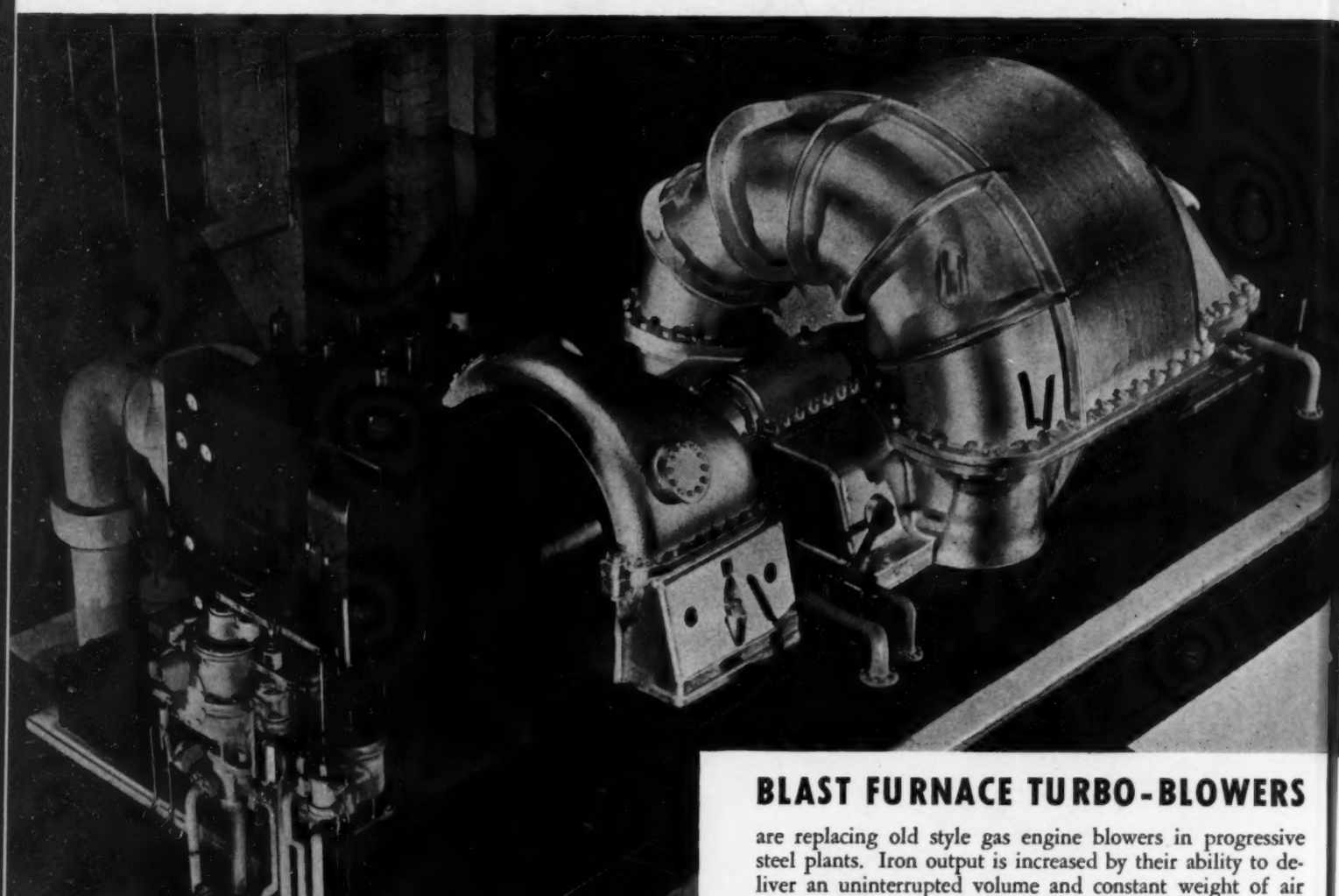
Speed control master switches — cam type and of narrow width to permit close mounting of several in front of the operator within easy reach. Short throw from off to full-on position reduces motion by the operator. Bulletin 1190.

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79th STREET • CLEVELAND 4, OHIO

MODERN ALLIS-CHALMERS BLOWERS INCREASE

Progressive Steel Men are Stepping-Up Plant Capacity by Using Modern, Power-Saving Allis-Chalmers Turbo-

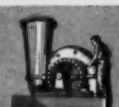


BLAST FURNACE TURBO-BLOWERS

are replacing old style gas engine blowers in progressive steel plants. Iron output is increased by their ability to deliver an uninterrupted volume and constant weight of air under all operating conditions. Turbo-Blowers have much smaller dimensions and are lighter than other types of blowers of the same capacity . . . require less space and can be erected on light, inexpensive foundations. Simple design of turbo-blowers, and the complete absence of rubbing parts, except for bearings, reduces maintenance and attendance to a minimum.

Steam and Hydraulic Turbines

Centrifugal Pumps



Blowers and Compressors

Texrope V-Belt Drives

ALLIS

1847 1947 A CENTURY OF SERVICE to Industry THAT MADE America Great

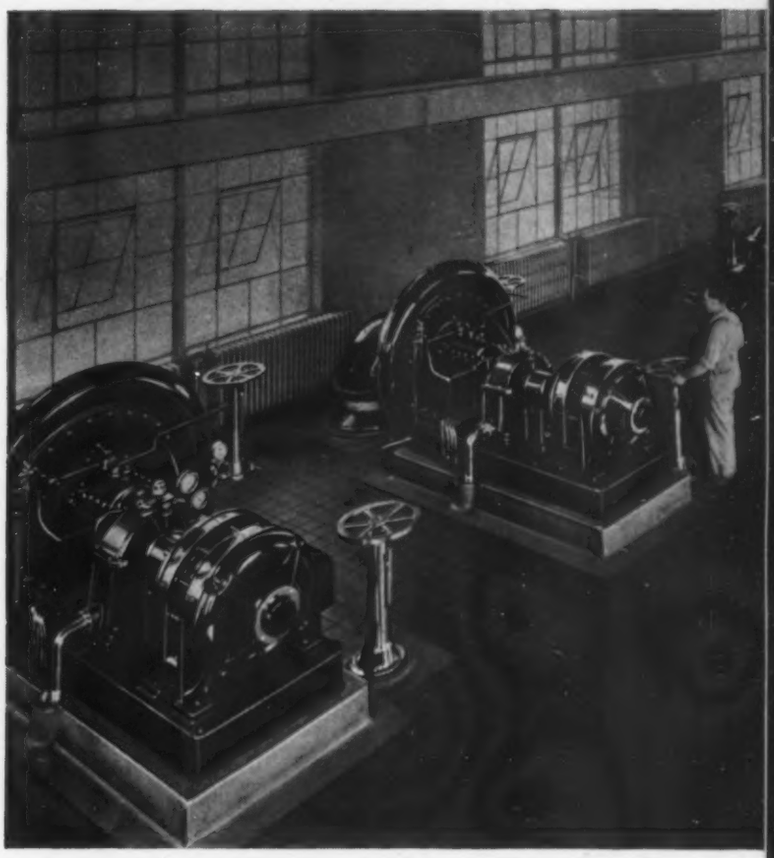
One of the Big 3 in Electric Power Equipment—

PLANT CAPACITY!

Blowers for Coke Oven Gas Exhausting and Boosting, Bessemer Converter and Blast Furnace Blowing.

COKE OVEN GAS EXHAUSTER

is another example of how Allis-Chalmers' modern blower equipment is helping to *increase* plant capacity in the steel industry. By accurate control of turbine speed, these exhausters of the centrifugal compressor type are able to maintain constant pressure in coke ovens, or in the gas collector main leading from the ovens, thus assuring maximum yield of by-products for more profitable coke plant operation! Allis-Chalmers is widely experienced in development of air and gas handling equipment . . . has many installations of turbo-exhausters from 10,600 cfm to 42,400 cfm, now operating in coke oven plants.



INTERIOR OF BOOSTER HOUSE

shows two Allis-Chalmers motor-driven gas boosters installed at a midwestern industrial plant. Accurate control is maintained by automatically operated suction valves.

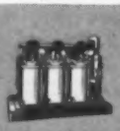
If you are developing new processes involving the handling of large volumes of air or gas . . . are expanding your plant facilities . . . or are operating older, bulky, slow-moving types of blowing equipment . . . it will pay you to call in an Allis-Chalmers blower and compressor specialist! See our nearby sales office, or write to ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN.

A 2159

CHALMERS

Transformers

Switchgear and Switchboards

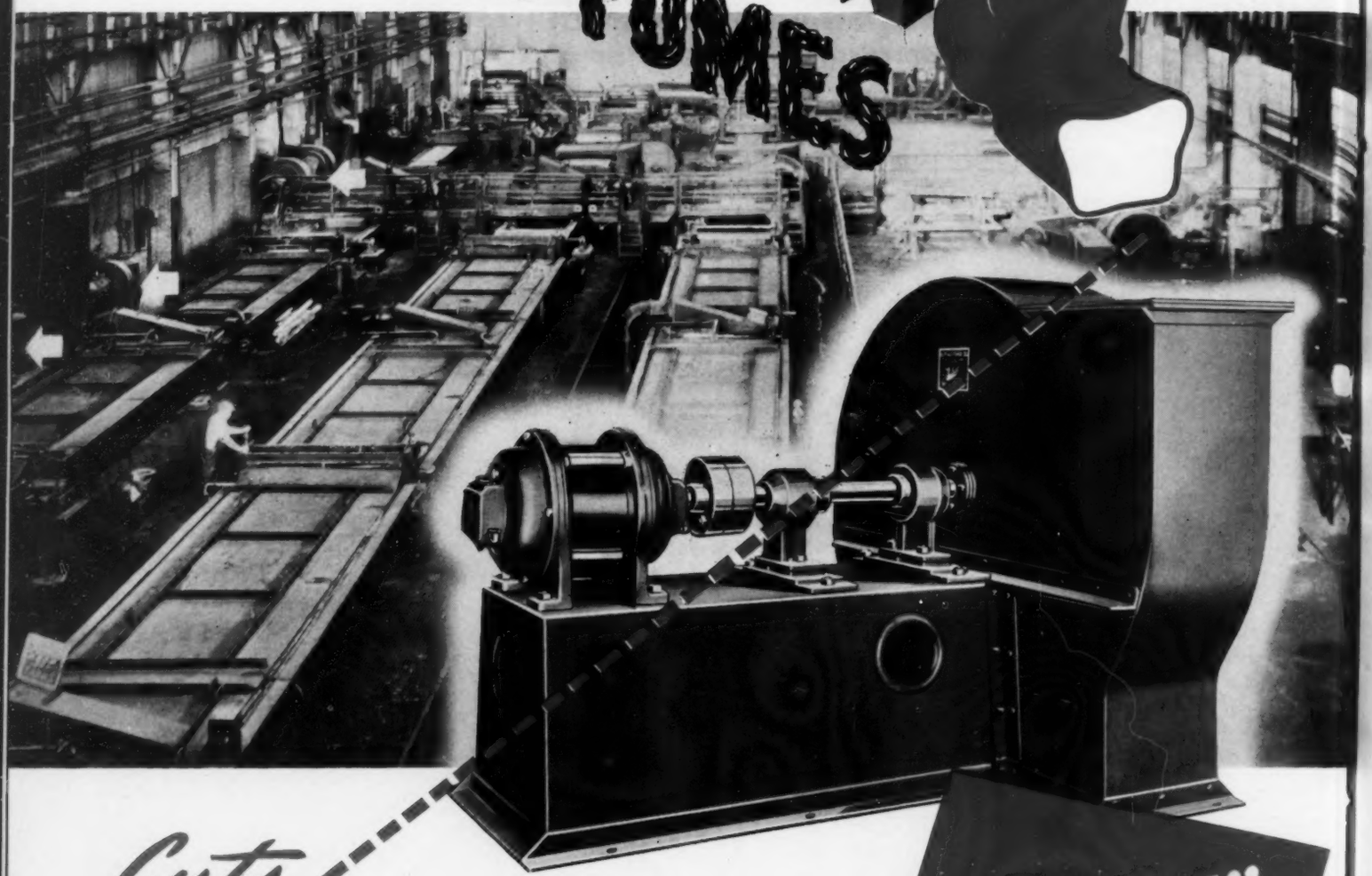


Rectifiers

Motors for Mill Drives

Biggest of All in Range of Industrial Products

PROTECTION against ACID FUMES



Cuts ... FUME HANDLING COSTS

Fume removal is VITAL here! That is why Inland Steel Company installed "Buffalo" Rubber-Lined Exhausters (B. F. Goodrich Vulcalock Process) to handle the corrosive fumes from tanks in their large-scale pickling process. Many types of gases can quickly destroy metal, but not rubber ... thus these exhausters provide far longer service, at lower cost.

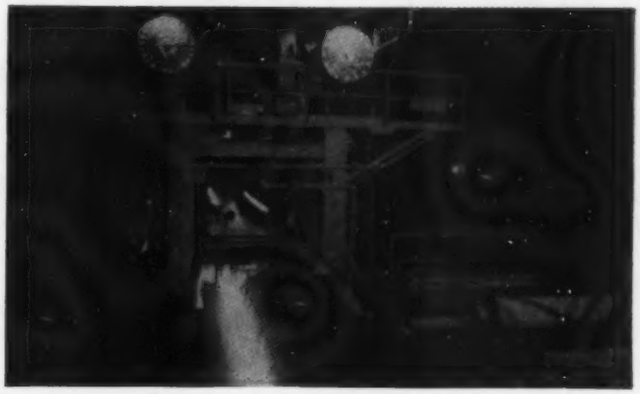
Do your operations call for exhausting of gases or materials? The complete "Buffalo" line offers you types and capacities of fans for trouble-free, economical delivery in every air application. For full information, simply write:

"Buffalo"
RUBBER-LINED
EXHAUSTERS

BUFFALO FORGE COMPANY
173 Mortimer Street Buffalo, N. Y.
Canadian Blower & Forge Co., Ltd. Kitchener, Ont.

How are costs cut with

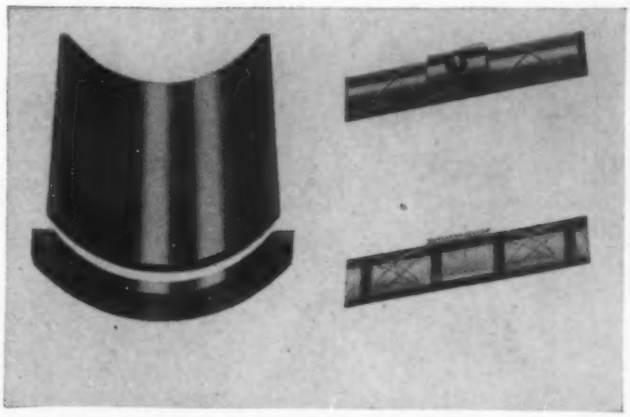
LAMINATED PLASTIC BEARINGS?*



1 **Costs are cut** with Laminated Plastic Bearings because these bearings customarily outwear metal bearings by several times. Impressive savings result from fewer shut-downs for bearing replacement. Costs are cut still further because . . .

2 **Water is used** for lubrication, ending the expense of grease and oil. Production techniques developed over a period of years give these bearings a hard, smooth surface with an extremely low coefficient of friction. Furthermore, . . .

3 **Power bills** are substantially lower. Many users of Laminated Plastic Bearings have kept complete cost records and they report surprisingly high power savings in addition to the many other cost-cutting features. You get all advantages if you . . .



4 **Select A-B-K** Laminated Plastic Bearings. The top engineering skill and extensive research facilities of American Brakeblok are combined to give the exceptionally long life and other benefits of A-B-K Laminated Plastic Bearings.

5 For full information on A-B-K Laminated Plastic Bearings and their application to your steel mill bearing problems, communicate with American Brakeblok Division, 4600 Merritt Avenue, Detroit 9, Mich.

American Brakeblok

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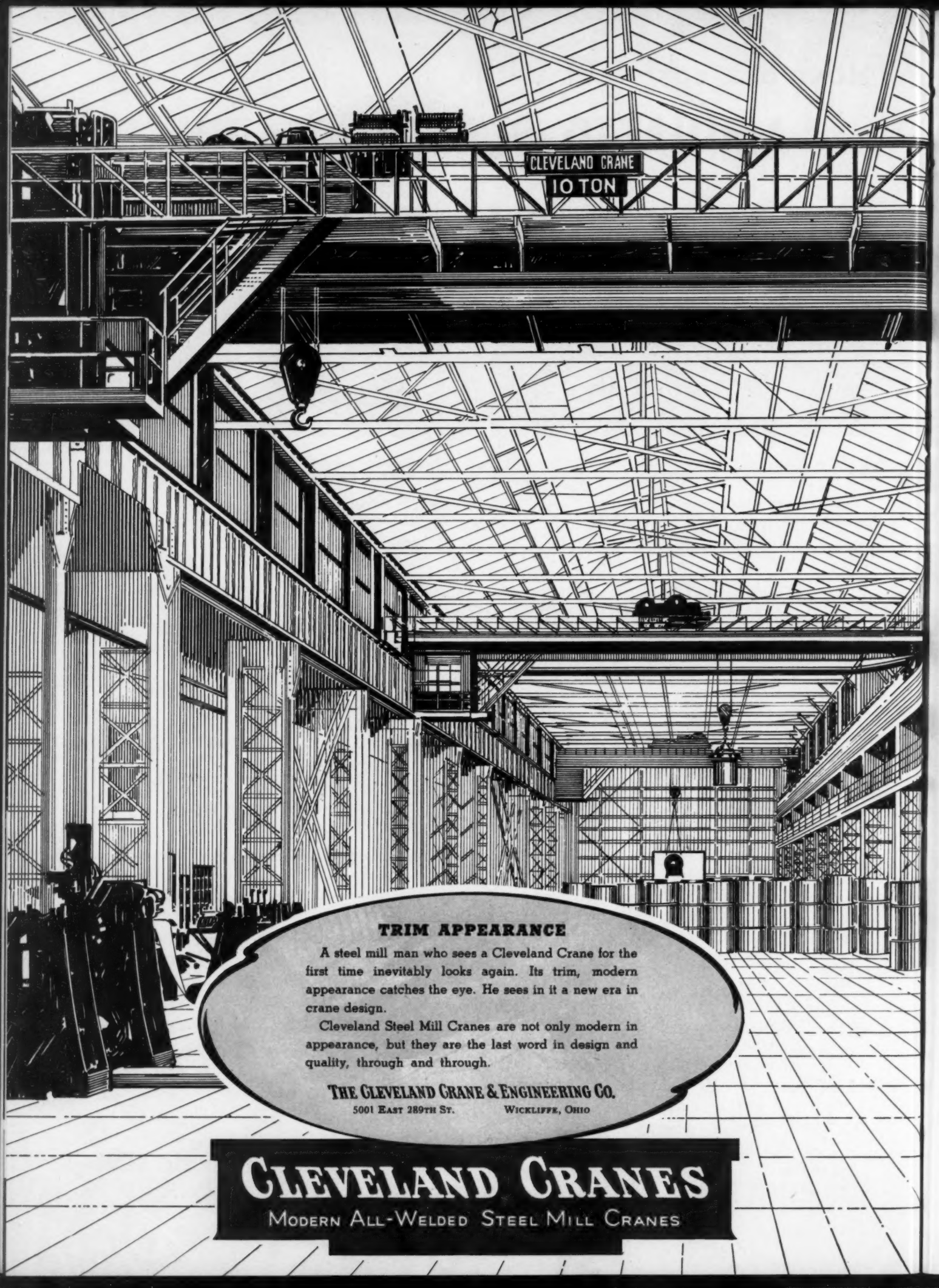

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FIGURES for 1946 give a total steel production of 66,363,848 net tons of ingots, and an operating rate of 72.2 per cent of capacity. This is 17 per cent under the 1945 tonnage of 79,701,624 (83.5 per cent operation), although it is the highest peacetime figure ever reached. The 1946 production consisted of 60,455,474 net tons of open hearth ingots, 3,327,815 net tons of bessemer ingots, and 2,580,559 net tons of electric furnace ingots.

▲

EARNINGS in the steel industry for the last quarter of 1946 showed encouraging increases. Contract negotiations between United States Steel Corporation and the union have started out in an atmosphere of free, cooperative bargaining. Portal pay suits promise to smother themselves by their own ridiculous volume. Union leaders in general are less bellicose in their attitude, perhaps seeing at last the handwriting on the wall. These are some of the factors which give an encouraging outlook for 1947.

▲

FROM Advertising Age: "Frustrated editors suggest the following New Year resolution for confirmed tub thumpers: When sending out publicity releases, always mention the kind of products your company makes."

We might add: "Also be sure to mention your company name."

▲

EVERY time we read a lot of statistics in which everything is given in percentages, we can't help but think that 100 per cent of two is only two, while a mere 10 per cent of 1000 is 100. Of course, we've heard that figures don't lie but liars figure, and brother, can they twist the figures! Typical of this are the arguments against flat reductions in income tax, which point out that a 20 per cent reduction will reduce taxes on a $3000 income only $38 but will benefit a $100,000 income to the tune of $12,460. They never add that, even after this reduction, the $100,000 income will still be taxed $49,841 (49.8 per cent) while the $3,000 income gets only a bite of $152 (5.1 per cent).

Another example of this kind of figuring is the Nathan report which reaches the conclusion that industry in general can raise wages 21 to 25 per cent without increasing prices.

AND speaking of income taxes, a reader says that a taxpayer is a guy who works hard and saves his money, and that a politician is another guy who, were it not for the first, would have to do the same.

▲

ANOTHER correspondent offers a sure method for balancing the budget. He says "Just tax people on the basis of what they think they're worth." There ain't that much money, son.

▲

THE completion of modernization of Weirton Steel Company's hot strip mill, as mentioned elsewhere in these pages, fulfills long-standing plans which were held up by wartime requirements for steel products. When "The Modern Strip Mill" was published by the Association of Iron and Steel Engineers back in 1941, it was decided to describe the Weirton mill, not as it was at the time, but rather according to the plans for rebuilding, which was to be done in the "near future." Production demands held the work up until now. We are glad that Weirton has at last made honest men of us.

▲

DURING 1946, 3,257,391 cars and trucks were turned out by the automotive industry of the United States and Canada. In 1941, more than 5,000,000 were produced. At present, however, the industry is operating at a rate of 4,500,000 units per year in spite of the tight situation on sheet and strip, both hot and cold rolled. Automobile producers hope to boost their assembly rate further about April 1.

▲

THOMAS ALVA EDISON, who was born February 11, 100 years ago, had 1097 patents issued to him. About one-third of these pertain to electric lighting and power distribution.

▲

REPUBLIC STEEL CORPORATION, purchaser of the government-owned steel plant at South Chicago, Illinois, is planning to expand the plant's facilities through the addition of a new merchant mill, the moving of a billet mill from the company's old plant to the new one, and perhaps the installation of several open hearth furnaces in place of some electric furnaces. This plant was described in Iron and Steel Engineer, October, 1944.

▲

A BOOKLET published by the National Machine Tool Builders Association lists "ten great inventions," as follows:

Power loom — Edmund Cartwright.
Sewing machine — Elias Howe, Jr.
Cotton gin — Eli Whitney.
Form-turning lathe — Thomas Blanchard.
Steamship — Robert Fulton.
Steam locomotive — George Stephenson.
Coal cutter — Francis M. Lechner.
Typewriter — Christopher Sholes.
Linotype — Ottmar Mergenthaler.
Continuous sheet mill — John B. Tytus.

It is not claimed that these are the greatest inventions, but each one, upon its appearance, was greeted with trepidation and resentment because it was feared that the machine would throw men out of work.

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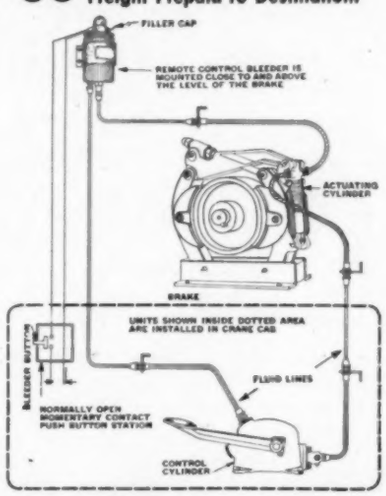
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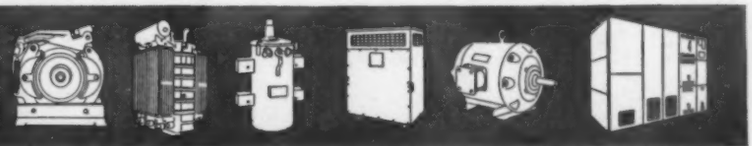

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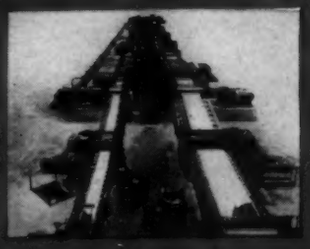

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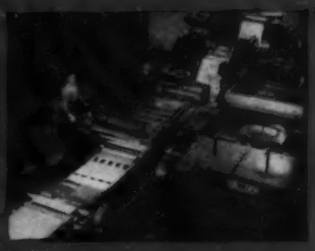

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Iron AND Steel ENGINEER

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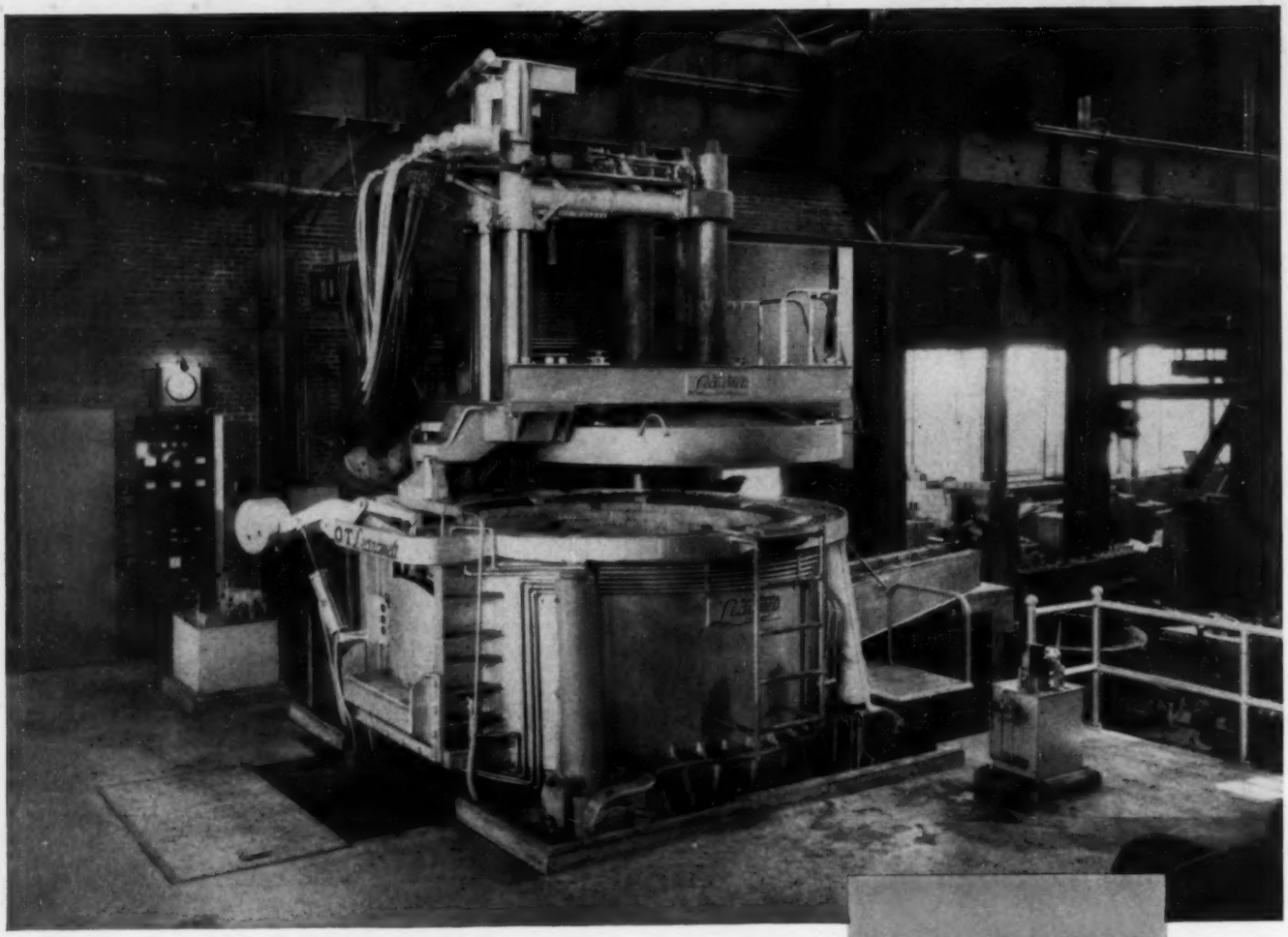

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WAR EFFECTS ON THE German Steel Industry

by Julius E. Graf

CHIEF ENGINEER

JONES AND LAUGHLIN STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

. . . . few Americans have had as good an opportunity to study the present status of the steel industry in Germany as has Mr. Graf . . . .

▲ ON the 29th of May, 1945 I was advised by my company that Mr. R. J. Wysor, who had been chosen by the State and War Departments of the U. S. Government to be the chief of the metallurgical branch of the United States Group Control Council for Germany, had requested them to release me for a year to act as the chief engineer of his branch. My company agreed to his request.

The metallurgical branch of the U. S. Control Council later became, and is now known as the "Metals Section, Industry Branch, Economic Division, Office of Military Government for Germany, United States." The office of Military Government is known as OMGUS.

MISSION OF METALS SECTION

The mission of the metals section can briefly be summarized as follows:

a. Recommend policies and develop plans for, and supervise the industrial disarmament of Germany, including prevention of manufacture of prohibited items and limitation of production of restricted items.
b. Recommend policies and prepare directives and instructions for, and supervise the control of the output of products of the ferrous, non-ferrous and light metals industries, and shipbuilding in the U. S. zone of occupation; recommend the removal, conversion and/or destruction of those specific types of metallurgical industries equipment considered as dangerous war potential.
c. Review the combined metals program requirements for products of metallurgical industries, including requirements for the military forces, for minimum essential German civilian needs, for reparations and restitution, and make recommendations therewith.
d. Determine production capacities of the ferrous, nonferrous and light metals industries, determine productive capacity required to produce approved production programs, and make recommendations as to facilities to be removed and disposed of as reparations.
e. Recommend policies and assist in preparing directives and instructions for the denazification of German industry and the use of German agencies for controlling the output of products of the ferrous, nonferrous, and light metals industries.

Where any of the items mentioned dealt with Germany as a whole, the discussions were on a quadripartite basis, i.e. United Kingdom, Union of Soviet Socialist Republics, French Republic and the United States of America.

My personal responsibilities were those dealing with the engineering problems of the metals section, as well as membership on commissions of other sections, such as machinery and equipment section, reparations and evaluation sections, and others. My duties carried me into the four zones of control of Germany as well as into Austria, France, Switzerland, and England. I traveled by plane, train, and motor conveyance, ferries and by foot. The mission, having primary responsibility with military and economic control, had little time or opportunity to gather information of purely industrial or commercial nature. It is only natural, however, that some developments were noted.

The following comments will be more or less confined to my impression of the effect of war on the steel industry of Germany.

Presented before the AISE Pittsburgh District Section Meeting, November 18, 1946

Figure 1 — At Liseder Hutte-Peine, the blast furnaces are charged by individual motor driven buckets on a monorail.

STEEL MAKING CAPACITY

Prior to and during the early years of the war, Germany reached an output of approximately 24,500,000 net tons or 22,000,000 tons (metric) of steel ingots per year, equivalent to a per capita production of approximately 700 lb per year. The per capita production of some of the surrounding countries was approximately as follows:

France	420 lb	Russia	250 lb
Belgium	998 lb	Poland	88 lb
Austria	215 lb	Italy	110 lb
Hungary	158 lb	U. K.	418 lb

These figures compare with a per capita production of approximately 1160 lb for the United States for the same year, 1940.

These figures are given so that one may realize that the steel industry of Germany, like the steel industry of the United States, and of the more progressive nations surrounding Germany was a vital part of its modern existence, if not the backbone of it. Germany, so far as its steel capacity and production was concerned, was, with the exception of Belgium, well ahead of all the surrounding countries as well as ahead of the United Kingdom. This excess was used for no good purpose.

Germany at the end of the war had an ingot capacity of approximately 28,500,000 net tons or 26,000,000 tons (metric), and this capacity was certainly not drastically reduced due to bomb damage, artillery fire, espionage or any other cause directly affecting the coke ovens, blast furnaces, open hearths, bessemer shops or mills. There was much superficial damage of buildings and cranes due to bombing, but in my travels I did not see one blast furnace or one battery of coke ovens which had been made inoperative due to direct war damage.

Wrecked buildings had been removed in many instances in making ready for operations, and in one plant the beam mill was operating without buildings save over the bloom heating furnaces. A very few major pieces of equipment such as mill housings were noted damaged irreparably. The observation was made after an inspection trip through the steel plants in the U. S. zone of occupation and a trip through five of the larger steel plants in the Ruhr just three months after Germany's collapse, "that 60 to 80 per cent of the steel capacity of Germany could be placed in operation in not over six to eight months time." This observation was substantiated some months later when a quadripartite commission, of which I was the U. S. member, made a more exhaustive examination and visited plants in all of the four zones. The damage to the steel plants was not in my opinion the factor which brought Germany to the point of surrender, but rather the breaking of public morale due to the bombing of the cities, displaced labor and last but most important the damage done to transportation.

DEVELOPMENT FOR WAR REQUIREMENTS

For some time previous to the actual war period, the steel industry of Germany had been under internal pressure for the production of materials for the armament program so that there was little time for the development of scientific technique with the exception of rather minor advancements. New capacity at the old and well established plants was most insignificant. The one and only major development for increased or, I should rather say, for the maintenance of the steel production was the Reichswerke Herman Goering, Watenstedt Werks near Salzgitter in the Hartz Mountain foothills.

This plant was designed under the general direction of the Brassert Company engineers and has already received some publicity in the technical papers of the United States and England. However, from my notes taken when at the plant in August 1945 with a United States commission and then again in May 1946 with a quadripartite commission, I will give a very brief description of the plant.

First, I will expand my previous statement that the plant as I saw it was for the maintenance of the prewar steel capacity, rather than for any assured increase in capacity. Germany's steel plants were all more or less geared to the use of imported ores from Sweden and other countries. This source of supply was vulnerable to discontinuance under reversals which were anticipated but were never realized to the extent planned. Seventy-five per cent of her steel capacity was in the Ruhr or close to Germany's western boundary. She therefore planned for production well inside

Figure 2 — Blast furnaces being charged at Eisenhuttenwerke Thale in the Soviet zone.

territorial Germany, and as would be expected, located it at the source of supply of her indigenous ores, and within reach of the midland canal system for the economic assembly of raw materials.

The construction of the plant was started in 1937 and operations began in 1940. The layout was planned for an ultimate capacity of approximately 4,000,000 tons of ingots, of which 2,000,000 tons had reached a state of completion and on which a production of 1,080,000 tons of ingots was obtained in 1943. The plant has not operated since it was captured by the U. S. Army. It is now in the British zone of control and in all probability will not be operated in the future.

The plant consists of an elaborate ore beneficiating department, having a capacity of approximately 22,000 tons of concentrates and sinter per 24 hour day, containing crushers, wet washing, Lurgi ovens, Krupp-Renn reduction furnaces, Dwight Lloyd sintering bands, and a Robins-Messiter bedding plant.

There are twelve blast furnaces in three batteries of four each, in this plant. Of these eight, 20 ft hearth furnaces and two, 23 ft hearth furnaces. The remaining two furnaces are in various stages of construction.

Three hundred thirty coke ovens in six batteries were built with 110 more under construction. The by-product plant deals with benzol, tar ammonia liquors and sulphur.

The steel plant consists of six 60-ton bessemer converters, two 1200-ton mixers, three 160-ton tilting type open hearth furnaces, and two 50-ton electric furnaces.

Rolling mills consist of a 42 in. blooming mill, 32 in. billet mill, 16 in. mill for light sections, 12 and 8 in. mills for rods and wire, and a narrow strip mill.

Separate departments located adjacent to the steel plant were engaged, when captured, in the production of bombs, shells, gun barrel parts, and heavy forgings. Steel fabricating departments were making all sorts of steel structures, including ship parts, bridges, pontoons, tanks and a great variety of other steel items.

Germany had developed her welding technique to practically the same extent as the engineers and operators in the United States. However, she was not satisfied to follow the conventional in either the welding or riveting of pressure vessels and boiler drums. As early as 1929, research was undertaken at the Deutche Rohrenwerke Mulheim Ruhr for the development of a process for the seamless rolling of these products. Two mills were subsequently built. On the larger of the two, seamless tubes are rolled having a maximum outside diameter of 72 in. and length of 60 ft with a wall thickness of 7 in., and weighing approximately 80 tons from ingots weighing approximately 120 tons. The rolling mill producing the large size tubing mentioned was built and placed in operation early in 1939 and was viewed with such favor that a duplicate was ordered from England but was never delivered.

At this plant, pressure vessels for highly corrosive chemicals requiring stainless or other high priced metals were made of relatively thin inner seamless tubing of the desired metal, and then reinforced by wrapping as many thicknesses as were necessary of a special rolled shape. This shape was prepared in coils of the desired length, upwards of 4000 ft, annealed, then heated, and

Figure 3 — Blast furnaces at the Herman Goering works, Salzgitter.

wrapped under tension over and around the steel shell until the desired strength was secured.

At the Mannesman Rohrenwerke Annen/Witten tubing from mild steel, low alloy steels, and stainless steels by a hot extrusion method was produced. Small tubing from 1.5 to 3.5 in. outside diameter was produced with wall thicknesses of 0.08 to 0.12 in. for soft steels, and 0.16 to 0.18 in. in stainless. The length of tube was approximately 22 ft. Slugs of the desired size were heated, descaled if necessary, and extruded in presses having a capacity of 1000 to 1250 tons. The actual extrusion portion of the cycle takes place in 1½ to 2 seconds, so that the tube emerges at high velocity with a minimum of contact of hot steel with the die-ring. Tubes having good surface and bores were examined. Strip rolling had not been developed to the extent that we have experienced here in the United States. Only one relatively wide strip mill had ever been built in Germany. This was the 58 in. mill at the Bandeisen Walzwerke-Dinslaken. The mill was built in 1936, was of the conventional U. S. Design, three slab heating furnaces, a roughing train of three 2-high and one 4-high mills, six 4-high finishing mills, two coilers, two flying shears for plates with necessary pilers, conveyors, etc. D-c current was supplied to the finishing stands through rectifiers. The finishing departments had the conventional continuous pickler, 3-stand tandem and reversing cold reducing mills, temper mills, etc. Novel equipment noted at this plant were a 6-roll cluster mill for rolling steel belting, strip lacquering, and hot dip strip tinning units. This plant has been awarded to the Soviet Union in partial payment of her reparations claim against Germany and in May of 1946 was in the process of being dismantled and packed for shipment.

In steel making, the ingot production has averaged about 60 per cent open hearth and duplex, 40 per cent basic bessemer, and less than 5 per cent electric furnace steel. Open hearth furnaces ranged in size from the 20-ton stationary units to 250-ton tilters. Bessemer converters ranged up to the 60-ton vessels previously mentioned at the Herman Goering works. At the Dortmund Hoerde plant at Dortmund, several 50-ton

vessels of the side blown type had been installed in 1942, while at the Mannesman Rohren Werke, Duisberg, 30-ton vessels with arrangements for both side and bottom blowing were noted. Oxygen had been used in the bessemer blast which was reported to have shortened the blow, reduced spittings, and produced a steel equalling open hearth grades.

DEVELOPMENTS FOR POSTWAR

As outlined under the mission of the metal section, one of our functions was to determine production capacities of the ferrous, non-ferrous and light metals industries, determine productive capacity required to produce approved production programs, and make recommendations as to facilities to be removed and disposed of as reparations or to be destroyed. This was one of the major tasks of the metals section of the Control Council, and required the most time, patience and perseverence. Yet it is the one that can for the present be talked of the least.

Germany had a rated capacity of steel ingots at the conclusion of the war of about 26,000,000 metric tons. The maximum production reached was about 22,000,000 metric tons. After much study and research and many long meetings with the other three commissions, Great Britian, Soviet Union and France, a quadripartite agreement was reached, whereby there would be allowed to remain in Germany, a total productive capacity of 7,500,000 metric tons with a controlled production of not over 5,800,000 metric tons per year. Production was to be subject to review and modification on a year to year basis. This tonnage figure is considered necessary for the German civilian economy, which, as outlined in the Berlin protocol, is to be no higher than the European average, excluding the United Kingdom and the Union of Soviet Socialist Republics. War potentials such as wide plates, electric steels, and heavy forgings have been prohibited, and this prohibition is made sure by a limitation on the size and number of plate mills, the size and number of electric furnaces, together with the importation of alloying elements rigidly restricted, and the size and number of forging presses definitely limited.

The breakdown in capacity of 7,500,000 metric tons of ingots was allocated to the several zones as follows:

Figure 4 — Shown here is war damage to heavy parts storage shop at the Krupp Gusstahlfabrik, Essen.

Figure 5 — Not much remains of the No. 6 machine shop at the Krupp Gusstahlfabrik, Essen.

	Present	Prewar
British zone	5,600,000 tons	20,600,000 tons
French zone	1,210,000 tons	3,000,000 tons
Soviet zone	390,000 tons	1,800,000 tons
U. S. zone	300,000 tons	600,000 tons

All capacity in excess of that allowed is to be removed as reparations or destroyed and some of this work is already in progress. The Krupp plant at Borbeck Essen had been dismantled approximately 50 per cent in May and is being shipped to the Soviet Union.

The reduction in the allowed steel capacity is one of the penalties being paid by Germany for being the loser in a war, the game of chance played by nations in which stakes of fabulous proportions are wagered. It is only one of the penalties, and there are many others. However, only one more is of direct interest in the consideration of the effect of war on the steel industry of Germany, and that is the potential demand for steel products caused by war damage to transportation, housing, and factories of all kinds, employing millions of workers in the larger cities of Germany.

When the Allied air force went to work on the transportation system of Germany, they did a job which merits the proverbial "well done". What they did not have time to do, the Germans themselves did in blowing up bridges, etc., in endeavoring to slow up the advance of the Allied armies. Not only were the railroad and highway bridges badly damaged but railroad equipment of all types in all the main marshalling yards was irreparably damaged. As late as June 1946 damaged equipment was still lying around, just as much of it did when Germany collapsed in May 1945 and is now being further damaged by nature and the elements. The quantity of transport equipment, particularly rolling stock, left over after the destruction directly or indirectly due to war is definitely inadequate for any normal standard of civilian economy and is therefore one of the reasons why a unified control for the whole of Germany should be established in order that the steel industry can at least begin a semblance of operations.

Germany did not depend entirely on her railroads for transport to keep the steel mills operating. A large percentage of the raw materials necessary for the steel plants, as well as finished products, was shipped over the network of canals and rivers. Here again are obstacles preventing normal navigation. A great many wrecks, barges, tugs, and vessels of all descriptions are

encountered, remains of destroyed bridges, and many temporary bridges constructed for war purposes are still in the way. In the Duisberg harbor on the Rhine river alone, over 150 vessels still lay on the river bed.

While limited navigation on most of the inland waterways has been, or will be resumed shortly, the shortage of floating stock, the hindrances to navigation, and wreckage at the harbors of the plants, will for a long time hinder the return of normal operations.

Destruction to Germany's cities was tremendous. The University cities, such as Heidelberg and Gottingen and a few others known not to be manufacturing centers and, of course, practically all the small towns and villages were spared from aerial bombing, although many have been damaged from ground fighting. Practically all of the large cities were partially destroyed. Many were destroyed to the extent that rebuilding on the present sites is quite questionable. Among these might be mentioned Essen, Kassel, Dortmund, Cologne, Darmstadt and Berlin. In Britain's hardest hit city, Coventry, the destruction was terrible and was estimated at 20 per cent. Kassel in Germany, bombed in retaliation for Coventry, and probably the hardest hit of all German cities was rated at 90 per cent destroyed.

The backlog of steel requirements established by the damage to transportation of all types, plus that required for the rebuilding of the cities including the requirements for minimum reconstruction or repair of essential civilian industry, with the reactionary result of a reduction in steel capacity of 71 per cent, does not paint a very pleasing outlook for the steel industry in the postwar period

DISCUSSION

PRESENTED BY

H. F. VOIGT, Sales Department, United Engineering and Foundry Company, Pittsburgh, Pennsylvania

J. E. GRAF, Chief Engineer, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

H. F. Voigt: I would like to mention recuperability. The Japanese did not have any recuperability, and while nothing was said about recuperability in Germany I understand that even though they were bombed in some of their steel mills, they had excess capacity, and like the Americans, they would go to work and get the thing back in operation in about a week.

Of course, in Japan the steel mills were not the primary target. Over there the main targets were the non-ferrous and the aircraft industries. In addition, the submarines waged their silent warfare, because the Japanese were dependent on imports, while the Germans had iron ore or access to it very quickly. The Japanese were not flexible enough to jump in and get the blast furnaces or open hearths going like the Germans. Also, the Germans had more capacity than they used for producing; is that not correct?

J. E. Graf: That is right, and I would like to make some comments. First I will refer to the Krupp plant at Essen, and while I do not have dates with me, as I remember it, the Krupp plant at Essen was bombed severely on three different occasions. Naturally it was a target because it was located where so much of the armament, armor plate and so on, was made in Germany.

On the first attack, that plant was dotted in almost every department. I have a record of every bomb that fell on that particular plant because I was on the Inter-Allied Commission that handled the complete study of the plant and decided what was to be done with the Krupp combine. The first time it was bombed on October 23, 1944, they immediately cleared away the debris, built wooden sheds, and went right back to work. About a month later, in that month they really got back to work, they were bombed again. Some of the same buildings were bombed, and the Germans made the same repairs again. It was bombed again on March 3, 1945; and that damage was still there when we studied the plant, although even then they had backbone enough to get in and start cleaning up. At one shop, the No. 4 machine shop, if my memory serves me correctly, they had cleared off all the damage on the building, and all the machine tools were sitting out in the open. They did not have a chance to put up a wooden shed or steel protection.

Secondly, they had excess capacity, because the Herman Goering works never operated to capacity, for they had never needed it. They had a sufficient stock of raw materials, great quantities of plates, bars, shapes, and pipes in the warehouses of many of the plants. They did not lack raw materials or rolled products. Thus, they did have a high degree of recuperability.

H. F. Voigt: Do you think that a steel mill can be put out of operation by bombing?

J. E. Graf: Yes, if it is hit at the right place.

H. F. Voigt: That is the sort of thing I studied, and it seems to me that a roof might go down and maybe some of the reheating furnaces will go down, but unless you get a direct hit at the proper point — say on the open hearth or blast furnace — it seems practically impossible to put a mill out of operation unless you made consecutive runs, with high explosive bombs, and the losses the airforce received in return were too high. The water supply is also a vulnerable spot.

Over in Japan, they used many small magnesium fire bombs and they just burnt everything up. In a town called Yawata, there is installed a 43 in. strip mill like the one at the McDonald works. Here they found that as a result of raids, and these fire bombs, absenteeism of the workers actually hurt production more than direct hits on the steel mills. Of course, the steel mills were always a secondary target. However, during one of the raids over Yawata with these fire bombs, this 43 in. strip mill was hit, and we counted something like twenty holes in the roof of the main motor room. These hits burnt out sufficient electrical wiring and main control boards to put the entire hot and cold strip mill down completely. They were lucky hits.

J. E. Graf: You have changed your question a bit. I said, yes, a mill can be knocked out, if it is hit at the right place. I did not say that steel mill equipment can be knocked out by bombs, and you agree, that it cannot except by direct hits. I saw some few pieces of equipment, a few drives and one blooming mill housing, that were destroyed irreparably. I say that a steel mill can be knocked out but you have to hit at the vitals, and that is usually the coke plant, the power generating equipment, or some place like that. The steel mill can

be knocked out if it is hit there, but so far as the equipment is concerned, it would take many, many runs of bombing to do any real damage to the steel mill equipment. I did not see a steel mill that was put completely out of the picture.

H. F. Voigt: I might tell you that in Japan at a battery of something like 60 coke ovens, one of these lucky spills of fire bombs hit right in an oven. They let it burn out, bricked out that particular oven and ran the rest.

J. E. Graf: In Germany there were no coke ovens destroyed, that I know of. I did not see a battery of coke ovens destroyed, or even partially damaged.

Member: You mentioned that there were some plans for using oxygen in the bessemer in Germany. Would you care to mention the names of those plants?

J. E. Graf: I will mention two of them, although there are others. One was at the plant at Salzbach down in the American zone. The name of the company was Eisenwerk-Gesellschaft Marimlianshutte. They have a plant at Unterwellenborn, and one outside of Haidhof. The other plant was the August Thyssen plant at Hamborn. There was another oxygen plant at the Guttehoffnungshutte, Oberhausen. It had been used to enrich blast furnace wind, but it had been moved to the Herman Goering plant, and as I understand, was not placed in operation.

Member: Mr. Graf, has any estimate been made of what the per capita tonnage of Russia will be after they move all this steel plant equipment?

J. E. Graf: All I can tell you is what a Russian major told me. He was a professor in the technical school at Moscow, and strange as it may seem, he thought enough of me to present me with an autographed book he had written on steel mill design. It is in Russian, of course. He told me when we were working up the figures, that when this next ten year program is completed, they will have in the neighborhood of 1350 pounds of steel ingot capacity per capita in Russia. Now remember, they are getting many of the German plants, they may get — note that I say they may get — the Herman Goering works; they want it, and if they want it they will probably get it. In addition to that, they have removed all of the 1,500,000 tons of excess capacity that was in the Soviet zone. So, they are building up their steel capacity very, very fast, and very, very cheaply.

AISE
DISTRICT SECTION MEETINGS

BIRMINGHAM — **APRIL 5, 1947**

"Modern Wire Mill Practice"

District Secretary: M. J. Booth, Birmingham 7-4232

BUFFALO — **MARCH 11, 1947**

"Maintenance of Cranes" — by A. J. F. MacQueen, mechanical and electrical superintendent, Atlas Steels, Ltd., Welland, Ontario, Canada.

District Secretary: H. C. Lindberg, Cleveland 2800

CHICAGO — **MARCH 4, 1947**

Maintenance Symposium.

District Secretary: A. J. Whitcomb, Wabash 4950

DETROIT — **MARCH 11, 1947**

"Duplex Steel Making" — By D. T. Rogers, General Metallurgist, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania.

District Secretary: E. F. Weiss, Madison 6860

PHILADELPHIA — **MARCH 1, 1947**

"The Application of Mercury Arc Rectifiers to Variable Voltage Drives" — By M. B. Antrim, assistant to electrical superintendent, Lukens Steel Company, Coatesville, Pennsylvania.

District Secretary: L. O. Morrow, Spruce 6765

PITTSBURGH — **MARCH 10, 1947**

"Continuous and Batch Annealing of Sheets and Strip" — By T. F. Olt, assistant director, research laboratories, American Rolling Mill Company, Middletown, Ohio.

District Secretary: J. S. Murray, Atlantic 2039

For additional information concerning meeting locations make contact with district section secretary.

IMPROVED DESIGN OF METALLIC RECUPERATOR

. . . . the increasing cost of fuel makes the use of recuperators relatively more economical . . . . although metallic recuperators have not been used as extensively as the refractory type, they offer advantages which should be considered . . . .

by Frank D. Hazen

HAZEN ENGINEERING COMPANY

PITTSBURGH, PENNSYLVANIA

▲ THE preheating of air for burning fuel has been practiced for many years, and in most cases economically so. It is a recognized fact that in the production and processing of steel the money spent for fuel is considered an important item.

The price of most fuels has already been increased, and with industry facing possible additional increases in fuel prices, any saving in this direction should be of paramount interest to management, and should receive their consideration more seriously at this time than any other time during the history of steel making.

With the installation of a properly designed recuperator, considerable savings can be accomplished with little more than the original expenditure, and without the drawbacks which nowadays invariably accompany attempts at saving by other means.

Various types of recuperators (air preheaters) have been used over a period of many years. The success of the recuperators has been predicated upon the length of time they were able to produce the required preheated air at a minimum maintenance cost.

In the interest of the use of preheated air to bring about fuel saving, the following facts are presented concerning recuperation:

Figure 1 shows per cent fuel saving at various temperatures of air and flue gas for rich fuels.

Figure 2 shows per cent fuel saving at various temperatures of air and flue gas for lean fuels.

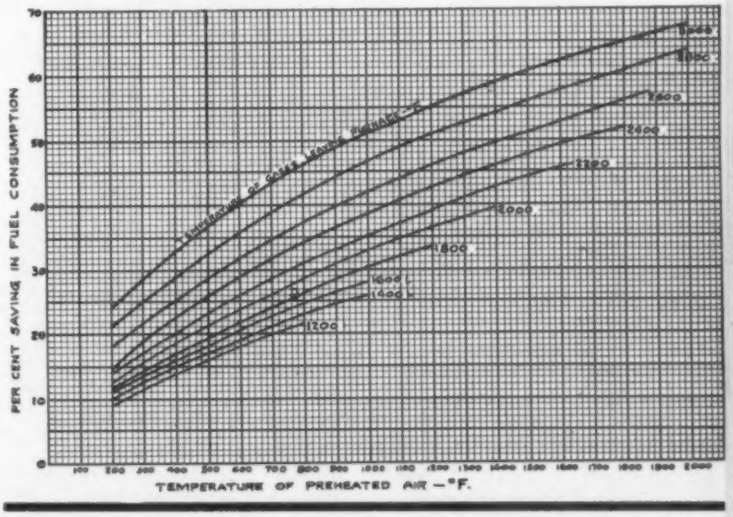
Both sets of curves are used by several of the recuperator manufacturers.

You will note that the percentages of fuel savings are not based on the savings brought about by the Btu in the air alone, but consideration is also given to the fue savings brought about by quicker and more complete combustion of the fuel when hot air is used.

Page 192 of "Industrial Furnaces" by Trinks, Vol. 1, 3rd Edition, refers to this additional savings as follows: "An additional effect, which is very important but rather intangible is not shown in Figures 143 and 144. It is caused by preheating of combustion air and consists in quicker combustion, and in a reduction either of the required excess air or else of the amount of unburned fuel passing out of the furnace."

Figure 143 referred to covers saving of fuel oil (or coal) caused by preheating of air, and Figure 144 covers

Figure 1 — These curves show per cent fuel savings, when recuperators are used, at various temperatures of air and flue gas for rich fuels such as natural gas, coke oven gas, coal, etc.



Presented before AISE Annual Convention, Cleveland, Ohio, October 3, 1946.

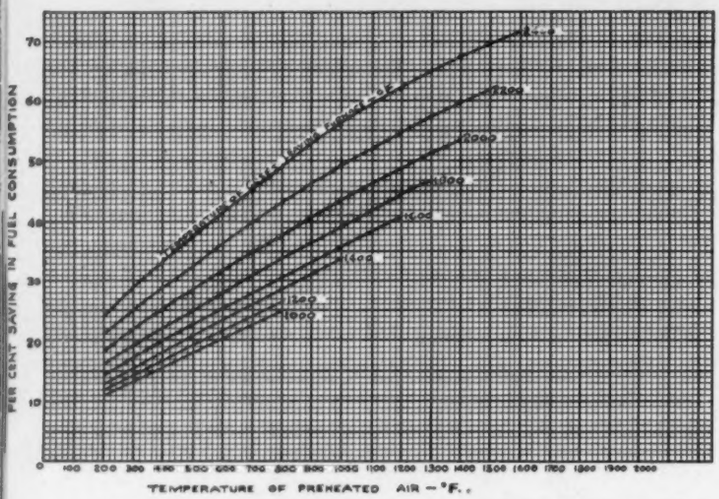


Figure 2 — These curves show per cent fuel savings, when recuperators are used, at various temperatures of air and flue gas for lean fuels such as producer gas, blast furnace gas, etc.

saving of producer gas caused by preheating of air, both based on Btu in air only.

Table I is copied from a paper entitled "The Application of Metallic Recuperators to Industrial Furnaces" by G. D. Mantle, read before the Iron and Steel Division of the American Society of Mechanical Engineers in Chicago, Illinois, September 26, 1930. This table, "shows the actual reduction in fuel consumption effected by recuperation on a number of typical metallurgical furnaces of different types and sizes. The results shown are not test figures, but represent actual fuel consumptions covering several months' operation under as nearly as possible equal conditions."

In only one case out of three is the per cent of fuel savings lower than that shown on Figures 1 and 2.

There are many slab and billet heating furnaces in operation without recuperation where the fuel consumption is 2,000,000 or more Btu per ton of steel heated. For example, let us take a particular furnace of this type, heating 40 tons of steel per hour; assuming the fuel consumption, using cold air, is 2,000,000 Btu per ton, and flue gas leaving the furnace at 1600 F, a fuel cost of 35 cents per million Btu, or $28.00 per hour, results in a fuel cost of $168,000 for a 6000-hour year.

Let us say a recuperator is applied to such a furnace, preheating the air for combustion to 660 F, and flue gas at 1600 F. Referring again to Figure I and following the chart line for the conditions just outlined, it is seen that the per cent of fuel saving is 22 per cent. This represents a saving of $36,960 for a 6000-hour year.

Although some companies purchase this type of equipment with the understanding that it will pay for itself within three years' time, in many cases such as this example, the installation of a recuperator of this type could be paid for in much less time than three years.

When increased furnace production is urgently needed, and the furnace is considered the bottleneck of a particular rolling mill output, the application of an improved design recuperator will prove to be even more valuable from an increased production standpoint than actual money savings in fuel. My company has been building metallic recuperators for more than four years. Service records have indicated that this metallic recuperator is giving excellent results.

Figure 3 shows an isometric assembly of the heating elements and header boxes of this recuperator. The header boxes are located above the flue. The recuperator flue can be placed most advantageously, either below or above ground level. The number of heating elements crosswise of the flue, as well as the number of boxes, will be dependent upon the capacity of the furnace. The heating elements suspended from the boxes are staggered so that the flue gases are carried around the tubes in that manner. Discharge from cold air fan is connected to the inlet air compartment of the header boxes. There are no joints exposed to hot gases, and no horizontal tubes to accumulate flue dust.

The heating elements consist of inner and outer tubes, which are for the most part made of stainless steel sheets. The inner tube of each element is seated into a U-shaped receptacle and properly sealed to insure tightness. Air is discharged through these inner tubes, returning through the annular space formed by the outer tube into the lower or hot air compartment of the boxes. The outer tubes are sealed to the lower compartment of the boxes.

Both outer and inner tubes are suspended from the top only and are free to expand independently of each other, regardless of the existing temperature differences. Complete elimination of air or gas leakage thus provided permits the use of high forced air velocity, resulting in rapid heat transfer rates. The inability to utilize high air pressure heretofore seriously limited the application of existing refractory recuperator designs.

In this recuperator, any row of elements, or any individual element (inner or outer tube) may be replaced readily. This is definitely a decided advantage over the old type recuperator. The replacement can be made comparatively rapidly and without removing the boxes from their location in the flue.

If the recuperator flue is placed underground, each box with its component heating elements can be raised vertically from the flue for inspection and cleaning, if necessary. Professor Trinks' "Industrial Furnaces," 3rd Edition, Vol. 1, Page 206, states, "Finally, a very important reason why recuperators, when installed, are not kept in use, is lack of accessibility for repairs, replacement, and cleaning."

Short hooks are welded to the bottom of each header box so that castable insulating refractories can be applied as shown in Figure 3.

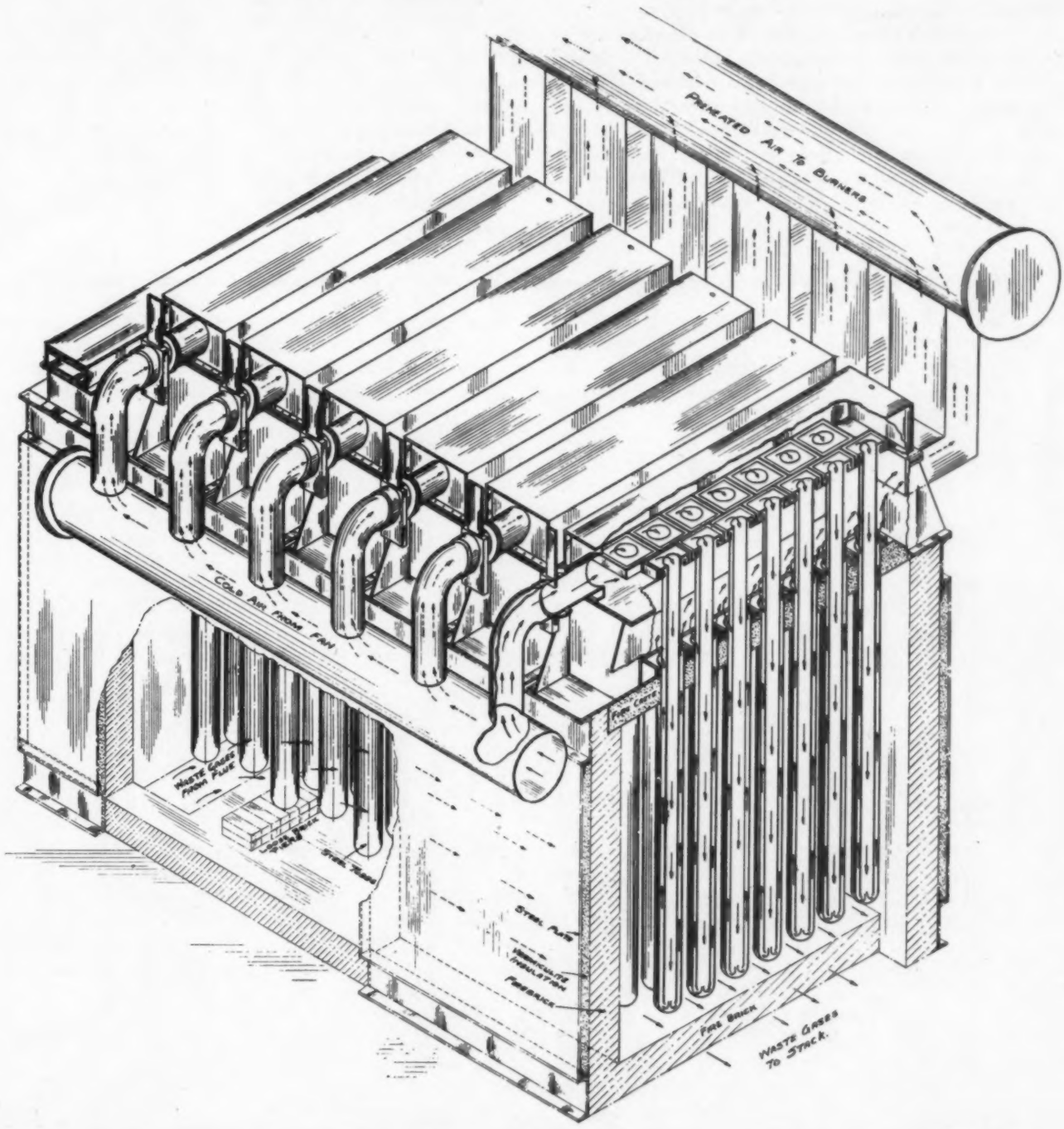
TABLE I

Type of furnace fuel	Continuous billet producer gas	Continuous billet coke oven gas	Continuous forging oil
Fuel consumption Btu per hr without recuperator	40,000,000	50,000,000	7,200,000
Fuel cost per 1,000,000 Btu	20c	30c	45c
Temp exit gases	1,600	1,900	1,600
Temp air	850	950	700
Savings, per cent	32	26	30

Figure 4 shows side view of one box, containing 12 heating elements, and also a cross section of the box. Section "XX" shows a cross section of an inner and outer tube. The inner tube has spacers to insure a definite annular space through which air is forced at high velocities. The following is further quoted from Trinks' "Industrial Furnaces," Vol. 1, 3rd Edition, page 199: "The best design of recuperator, therefore, from a heat-transfer standpoint, is that in which the flue gases travel slowly in large passages, while the air is passed through at high velocity. In metallic recuperators, the latter requirement is easily fulfilled, but in tile recuperators, the joints cannot be made and kept tight, in spite of the greatest care, and even a slight excess of pressure of the air over that of the gases causes excessive leakage."

The circular ring or annulus formed by the inner and outer tubes, through which a thin layer of air passes at high velocity, creates a most rapid means of heat transfer from the outside tube into the air. The inner tube also serves as secondary heat-transmitting surface, absorbing heat by radiation from the outer tube and giving it up to the air stream both inside and outside the inner tube. As a result of the rapid heat transfer, the metal of the outer tubes is kept at a low temperature

Figure 3 — Isometric view of improved, metallic, recuperator.



compared with the temperature of the surrounding flue gas.

The fact that these tubes are formed of stainless steel sheets rather than a cast alloy makes it possible to use a thinner gauge of metal and further contributes to the rapid heat transfer and cooler metal temperatures. Leakage through porous castings is avoided by the use of rolled sheets.

The first row of elements is subjected to the most severe service, due to the fact that it must withstand not only the temperature of the flue gases, but also the reflected heat from the brickwork of the flue. In view of this, the curves shown in Figure 5 have been prepared. These curves show the maximum metal temperature for the first bank of elements, which are outer tubes of 7 ft 9 in. in length, and an air temperature of 40 per cent of that of the flue gas. The upper line shows the maximum metal temperature of the outer tube and the lower dotted line shows the maximum temperature of the inner tube of the first bank of elements.

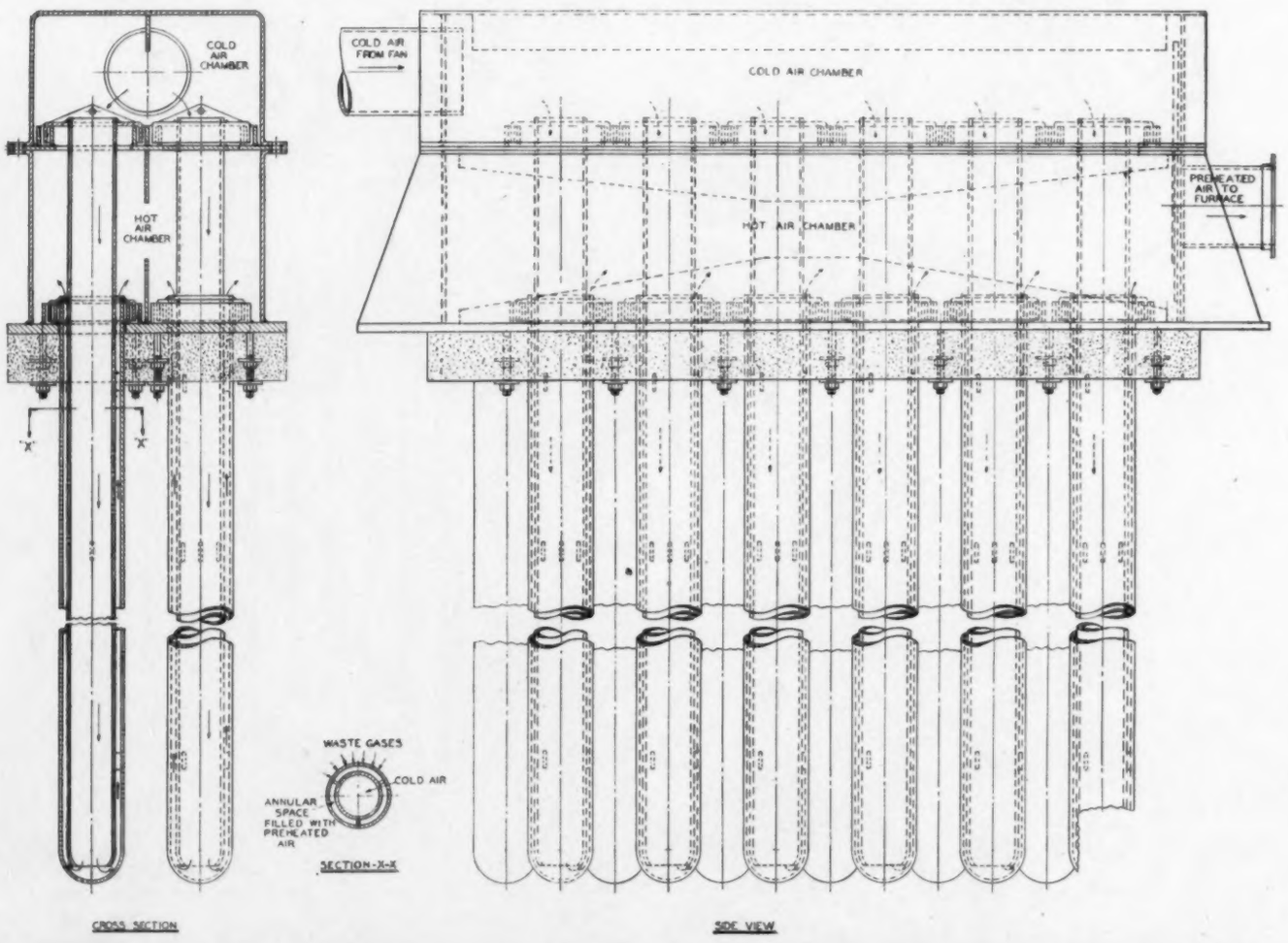
It has been found that, by using a higher pressure drop of the air through the tubes, the metal temperature can be reduced accordingly, as evidenced by the curves at the upper right which, if projected downward, would show a considerable drop of metal temperature of both outer and inner tubes.

In most cases, the flue gas temperature of the average heating furnace does not exceed 2000 F; consequently, with 5 in. of pressure drop of air through the tubes, the metal temperature of the outside tube is slightly under 1400 F. The manufacturers of stainless steel advise that such standard types as No. 309, 25-12 materials do not start to oxidize appreciably until the metal temperature approaches 1900 F. It is reasonable to assume, and has been proven in practice, that a very long life of the metal can be expected at temperatures of 500 degrees below the critical oxidizing point of the metal used.

On all our recuperator installations either a hand or automatic controlled bleeder is installed in the hot air header, to insure that air goes through the tubes at all times, regardless of the quantity of air being used in the furnace. In other words, to draw a parallel, no one would ever think of continuing to operate a water tube boiler without water in the first bank of tubes.

When the bleeder is controlled automatically, a 2-point control is most desirable with the first temperature control located in the hot air outlet of the first box containing the first row of tubes, and the second temperature control in the hot air header. The first control is generally set 150 F higher than the second control, to give protection to the first row of tubes.

Figure 4 — Heating elements of recuperator unit are hung vertically, thus eliminating expansion stresses.



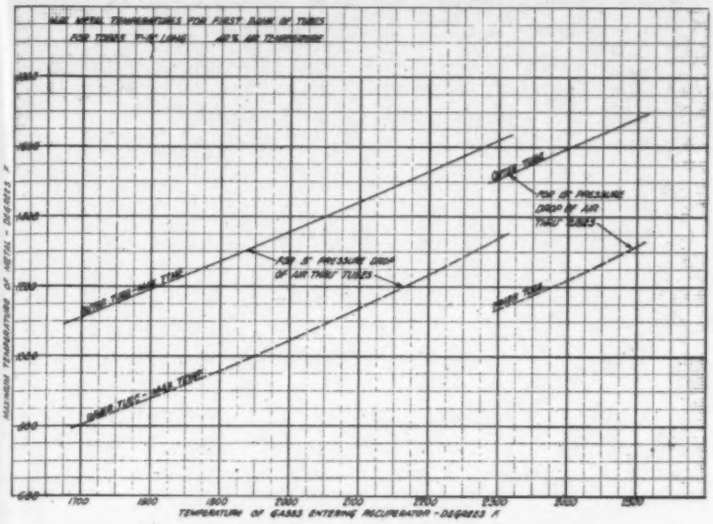


Figure 5 — Increasing the air pressure reduces the temperature which the metal tubes must withstand.

With this arrangement of protecting the metal in the tubes, there is no danger of creating secondary combustion in the flue gases, which often took place with the old conventional procedure of attempting to lower flue gas temperatures by inducing cold air into the flue.

A higher pressure drop of air through the tubes than that shown in Figure 5 is recommended when used in connection with soaking pit furnaces where the exit flue gas temperature may be between 2100 and 2400 F. This high pressure air may be used with this recuperator since there is absolutely no leakage unless, of course, an accident might render controls inactive and burn out a tube. However, in such a remote and unusual case, the recuperator could be kept in operation until the end of the week, as the only result would be leakage of air into the flue.

Since the higher-pressure air is required only for the first tubes (those exposed to the hottest gases), and its volume comprises only a low percentage of the total, a small separate blower can be used to supply these tubes, and the total power consumption then is only slightly increased over what it would be with all low-pressure air.

It might be well to mention also another improvement in the design of this recuperator which is contributory to long life of the tubes, and that is the fact that they are suspended from the top only and are free to expand and contract with no undue stress exerted upon the metal.

This latter feature, together with the fact that it is possible to maintain metal temperatures of the tubes at least several hundred degrees lower than the critical point of the metal used, eliminates the major causes for failure of older types of metallic recuperators.

As previously mentioned, this improved type of metallic recuperator has been built for approximately four years and service records indicate excellent results. All predicted savings have been realized. At the present time, five recuperators are being built for application to five slab heating furnaces, each having a capacity of 117 tons per hour. When completed this will be the largest single installation of this type ever built.

DISCUSSION

PRESENTED BY

C. J. WYROUGH, Superintendent Steam, Efficiency and Combustion, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

F. D. HAZEN, Hazen Engineering Company, Pittsburgh, Pennsylvania

W. TRINKS, Associated Engineers, Pittsburgh, Pennsylvania

E. W. FITCH, Combustion Engineer, Republic Steel Corporation, Youngstown, Ohio

WALTER N. FLANAGAN, Carnegie-Illinois Steel Corporation, Pittsburgh, Pennsylvania

E. C. McDONALD, Combustion Engineer, Republic Steel Corporation, Cleveland, Ohio

H. S. HALL, Fuel Engineer, Lukens Steel Company, Coatesville, Pennsylvania

KARL DENGG, Research Laboratory, Diamond Alkali Company, Painesville, Ohio

J. D. KELLER, Consulting Engineer, Hazen Engineering Company, Pittsburgh, Pennsylvania

C. J. Wyrough: We all know that with the increase in the cost of fuel and all other factors that are included in the production of steel, it becomes more imperative that everything within reason be done to effect the greatest economy in the use of these materials. The use of recuperators has long been a recognized method of reducing fuel costs, with most of the recuperators being of the refractory type. The adoption of metallic recuperators has, up to the present, been slow because of the maintenance difficulties and short life of these recuperators. The installation having the longest service record, mentioned by Mr. Hazen, will be watched with interest, and if it shows good results it would, no doubt, lead to a revived interest in this equipment.

F. D. Hazen: Our installation having the longest service record is in excellent condition after having been in operation for four years. We believe four years is sufficient time to prove the merit of this equipment.

Prof. W. Trinks: Most fuel engineers in steel plants make a great mistake in figuring the saving to be obtained by recuperators. They base the saving on the present price of coal. If the recuperator lasts four years, they should base the saving on the cost of coal as it will be two years from now, and if it is a design of recuperator which lasts ten years, then they should base their saving on the probable cost of coal five years from now.

I remember distinctly that when I came to Pittsburgh from Philadelphia in 1900, coal came down the Monongahela river in barges at 65 cents a ton. Today it is $4.30 a ton. Therefore, if at that time we could have installed a recuperator which would have lasted until today, there would have been considerable saving.

When this one thought of computation is brought before the management they say, "Who knows what

the price of coal is going to be two or three years from now?"

You can come right back with this answer, "You are now expanding the capacity of your mill, aren't you? How do you know what the demand for steel will be two or three years from now?"

The demand for steel is more uncertain than the price of coal. I think that the increase in cost of fuel and labor is more certain than the demand for steel.

E. W. Fitch: I would like to ask Mr. Hazen his experience with steel recuperator tubes when the furnace is fired with coke oven gas having a high sulphur content. Does the sulphur have any material effect on the tube life?

F. D. Hazen: We have one installation in service where the furnace is fired with coke oven gas having sulphur content. This furnace was fired for approximately two years with this gas and at the end of that time we did not notice any detrimental effect.

Walter N. Flanagan: I think Mr. Hazen omitted one vital reason for installing recuperators wherever possible in heating furnaces, namely that in most cases the use of preheated air also increases the capacity of the furnace, or conversely, enables a smaller furnace to attain the same output.

Also, we of the steel producing companies, and particularly those of us who make stainless steel, are indebted to Mr. Hazen, for promoting the use of one of our own products. It always seemed ridiculous, even before the days of stainless steel, that we had to go to refractory recuperators instead of using our own product by proper design.

E. C. McDonald: How does your recuperator compare in price with tile or carborundum?

F. D. Hazen: Everything considered, it is almost unfair to even attempt to make a price comparison between our metallic recuperator and the carborundum or tile types.

It is a conceded fact that considerable leakage of gas and/or air occurs with the carborundum or tile types of recuperators. In case of air leakage into the flue gases, a much larger quantity of air must be put through the recuperator to get the desired quantity of air to the burners. If there is a gas leakage into the air, then a false air temperature is created from the hot flue gases, and the burners are carrying over a certain quantity of burned gases, cutting down the efficiency of the burners. With our recuperator there is no such leakage and this fact alone would eventually compensate for any difference in the original installation cost.

H. S. Hall: How easy is it to clean your tubes? In case you get a deposit on the tubes from the flue gas, how can you clean them?

F. D. Hazen: Since the tubes are suspended vertically our experience to date shows there is very little deposit, if any, of flue dust on these tubes. In other words, the vertically suspended tubes allow the flue dust to drop freely to the bottom of the flue. Should the flue dust be of such nature that particles would adhere to the sides of the tubes, they could be very easily blown off with air. This vertical suspension is a decided advantage over tubes placed horizontally which would tend to catch and hold flue dust.

Cement companies seem to have a more serious dust problem than most other industries, and that is one of the chief reasons why they have shown so much interest in the design of the metallic, vertically hung recuperator.

Karl Dengg: Mr. Hazen mentioned that cement companies are interested in this recuperator. Is the recuperator applicable to all kinds of rotary furnaces? Can it improve the rather low efficiency of a furnace like the type of rotary furnace which is used for roasting chromite in the manufacture of sodium bichromate, for instance, a furnace which is shorter than the cement kiln?

J. D. Keller: I would say that there is probably a chance of better recovery of heat on that type of furnace, because it is shorter, since your flue gases would leave at a higher temperature, and therefore the efficiency is quite low. You have more heat to be recovered at the recuperator and you should, therefore, have a higher saving than on the cement kiln. I do not have any experience to back that up, but with heat transfer, it should be so.

Karl Dengg: Yes, but has anybody used the recuperator on this type of furnace, used in the cement plant?

J. D. Keller: No, not so far as I know at the present time.

The A I S E Annual Spring Conference

Under auspices of the Rolling Mill Committee

BENJAMIN FRANKLIN HOTEL
PHILADELPHIA, PENNSYLVANIA

MAY 26-27, 1947

Spot Conversion for ADJUSTABLE SPEED DRIVES

. . . . spot conversion units for variable speed drives are being built in package units which can be installed easily at the point of use . . . .

by
W. R. Hough, CHIEF ENGINEER
and
R. A. Geuder, MANAGER OF APPLIED ENGINEERING
RELIANCE ELECTRIC AND ENGINEERING COMPANY
CLEVELAND, OHIO

▲ THE need for adjustable speed in the steel industry as well as in most other processing industries stems from a universal demand, everywhere apparent today, for more and more production from old as well as new equipment, without increasing costs or decreasing quality.

What adjustable speed can contribute to economical production is, of course, most easily recognized where the process is one which concerns a wide range of products or gauges of products. Take, for example, the rolling of different thicknesses of steel strip. It affords an excellent demonstration of how the availability of adjustable speed promotes economical production. Obviously, if a rolling mill is designed to take a 35 per cent reduction on 0.040-inch strip at 1000 feet per minute, it would require a far greater horsepower to take the same percentage reduction at the same speed on a 0.125-inch strip. However, since the coils of a 0.125-inch material to be rolled will be shorter than lighter gauge coils of the same weight, they can, with an adjustable speed arrangement, be handled at enough lower speed to make unnecessary any increase in the horsepower required.

Another instance of the value of adjustable speed for economical production is where the characteristics of the material being processed change to some extent from day to day, requiring more delicate manipulation at certain times. In other words, while ostensibly the same material is being handled at all times, there is enough variation in the product to make it impossible upon occasion to run it at full speed without encountering breaks, off-gauge sections, or other defects avoidable at lower speeds.

The contribution of adjustable speed to the control of quality has equally interesting possibilities. For instance, in a wire drawing application, the speed with which the wire is drawn through the die creates heat. Excessive speed resulting in excessive heating will cause undue wear on the die with a resultant off-gauge production. In addition, the excessive heat at the die may produce a change in the physical structure of the wire, frequently making it difficult to obtain the proper characteristics in the finished product. With adjustable

Figure 1 — Simple tandem mill arrangement showing strip under tension.

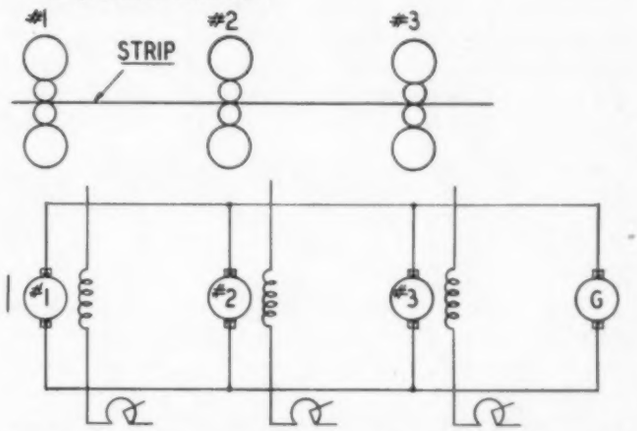
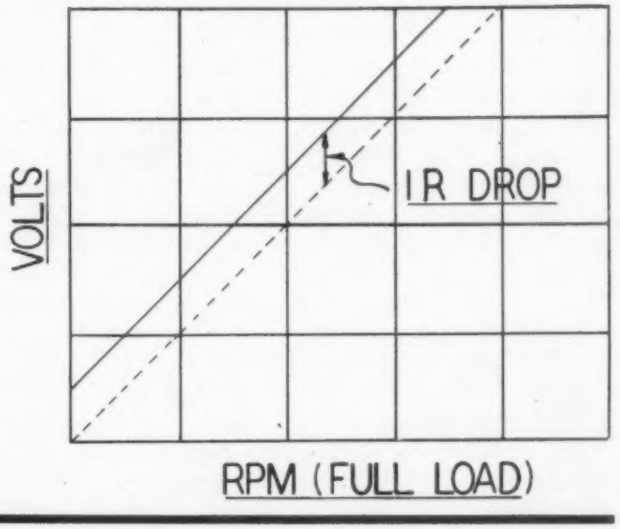


Figure 2 — Curve showing relation of applied voltage and speed with no IR drop compensation.



Presented by R. A. Geuder before AISE Annual Convention, Cleveland, Ohio, October 2 1946.

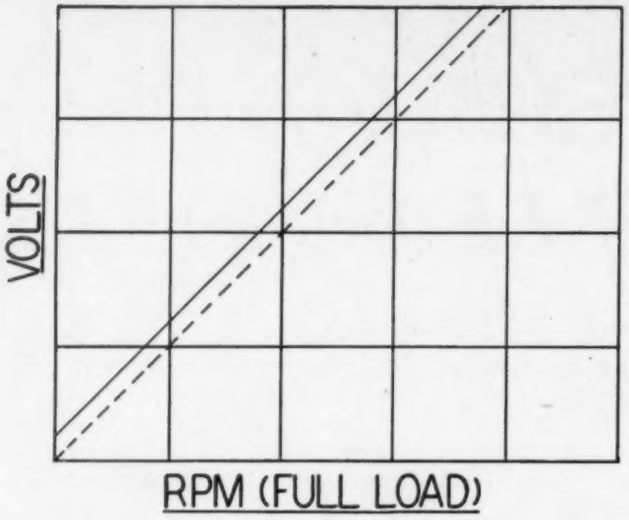


Figure 3 — Curve showing relation of applied voltage and speed with IR drop compensation.

speed available, a satisfactory balance can be struck between top quality and top speed.

In almost all processing machinery, it is necessary from time to time to accelerate and decelerate. This may be necessary because the machine has to be reloaded, provided with a new batch of raw material, such as a new coil for a rolling mill, or it may be because the machine has to be unloaded, a coil of the desired size removed from the finishing end of the equipment. In other words, even when the operating speed of the machine is predetermined and essentially fixed, we may still be faced with the requirement to accelerate to operating speed and decelerate to rest from operating speed.

As operating speeds on processing equipment are pushed to higher and higher levels to increase production and reduce costs, there is an ever-increasing emphasis being placed on the smoothness and uniformity of acceleration and deceleration. In many cases, particularly those involving the processing of a light or thin web of material, it will be found that jerky acceleration or severe stopping results in breaks and off-gauge material. And, regardless of any other causes, smoothly controlled acceleration and deceleration result in far less mechanical abuse of the apparatus.

With due regard for the work of eminent engineers who have devoted themselves to the problem of securing adjustable speed from an a-c power source, there has not yet appeared any solution that in any way approaches the flexibility, simplicity, and economy of the variable voltage method. Even in those European countries where, because of limited material resources, more has been done than here in exploring the possibilities of adjustable speed from a-c circuits, there is reported a very definite trend toward the use of variable voltage control.

Of course, we could consider a large plant having d-c distribution as an example of one way to solve securing adjustable speed from a-c power. Here alternating current purchased from a central station or generated in the plant's own powerhouse is sent to a motor room, converted to direct current and distributed to the manufacturing areas of the factory. Adjustable speed d-c motors placed out on the processing machinery throughout the plant could then be assumed to provide the answer to adjustable speed with which to meet the requirements of quality control and economical production.

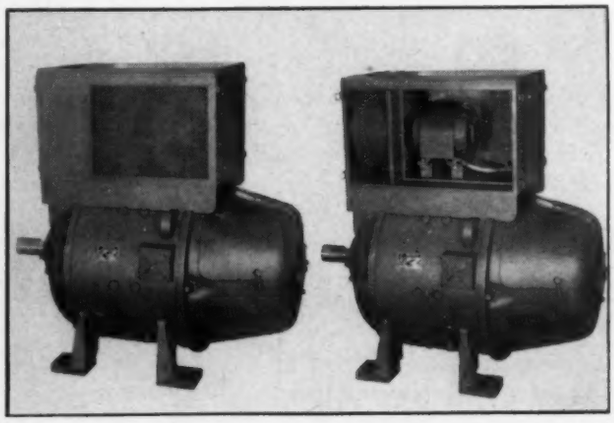
However, steel mill engineers in their progressive thinking recognize that for large processing equipment, such as a 5-stand tandem cold mill, it is uneconomical, if nothing else, to attempt to operate several 1000 hp motors from a 250-volt shop supply with conventional contactor starters, etc. They realize the desirability of providing a conversion unit in the form of a motor generator set whose sole purpose is to provide adjustable voltage, or variable voltage if you wish, to the several mill motors. Not only are large accelerating contactors and accelerating resistance eliminated, but there is provided a wider range of adjustable speed than could be obtained from a fixed d-c potential.

The good judgment of these steel mill engineers has been thoroughly demonstrated, as year after year the top operating speeds of steel mill equipment are pushed higher and higher to obtain more production at reduced costs.

In this country, as elsewhere, a great deal of our engineering is necessarily influenced by previous experience. Many times an engineer asks himself, "If the solution reached on machine 'X' in the bar mill is giving such excellent results, why isn't the same solution applicable to the new machine proposed for the tube mill? Granted that the tube mill auxiliary machine requirement is much smaller than the satisfactory application in the bar mill, fundamentally do not the same requirements exist on both?"

That is exactly the logic which has made variable voltage control an accepted tool in all industries for all types of processing machinery requiring adjustable

Figure 4 — At very low speeds, auxiliary ventilation is required to maintain constant output torque continuously.



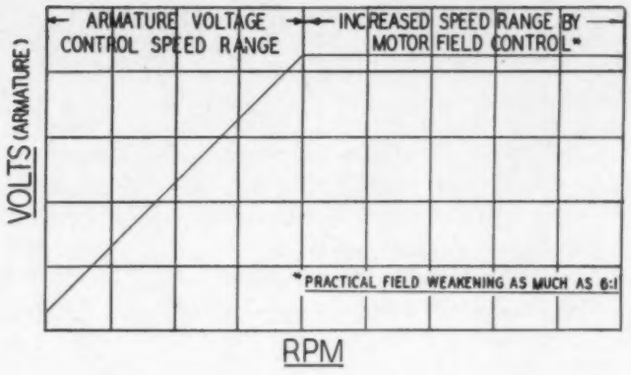

ARMATURE VOLTAGE CONTROL SPEED RANGE
INCREASED SPEED RANGE BY MOTOR FIELD CONTROL*
VOLTS (ARMATURE)
*PRACTICAL FIELD WEAKENING AS MUCH AS 6:1
RPM

Figure 5 — Variation in speed is shown with variation in applied armature voltage and motor field control.

speed for any of the reasons already enumerated. Further investigations have revealed many advantages aside from the acknowledged superiority of performance. For instance, a small conversion unit installed at the machine to be operated, spot conversion, obviously requires considerably less maintenance than a single large generating unit upon which the operation of the entire mill depends. Moreover, when the machine with which the spot conversion unit is associated is not in production, the latter can be turned off after which it requires zero attention. By contrast, a central generating unit requires constant attention, but probably must have more care when it is operating only 10 per cent loaded than when it is carrying its full load.

Many large organizations have made studies of the relative cost of generating and distributing direct current as compared with distributing and converting alternating current for adjustable speed purposes at an individual machine. In making such a study the analyst frequently faces the statement, "There is at present enough or more than enough direct current already available throughout the plant."

Such a situation must be evaluated from two points of view. Of course, the fact that the original installation cost 'X' dollars, a part of which should be charged against operating any new machine, cannot be ignored. However, we should certainly refrain from concluding that the plant has reached its peak of production, will never require any additional direct current capacity, and therefore has available in the margin above present requirements all the direct current that will ever be required. Such a conclusion ignores the fact that expansion is actually under way and is by no means the last that may be undertaken. Therefore, whether there already exists sufficient direct current for immediate adjustable speed purposes is not of itself the only criterion. First, because it is an economically unsound premise and second, because in so many cases it does not give the full answer to the requirements of modern machinery.

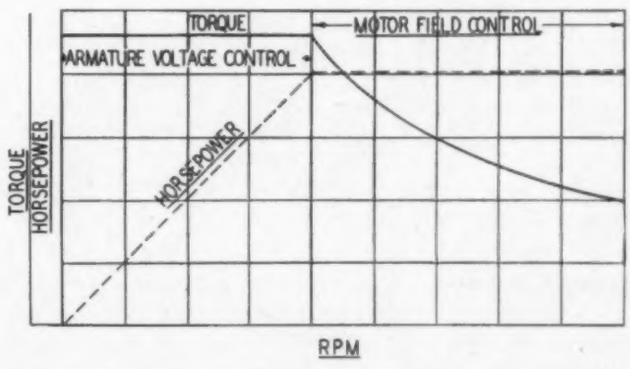
When the steel mill electrical engineer originally saw fit to provide a conversion unit for his 5-stand tandem cold mill, he placed the motor generator set along with its control in a motor room where he could keep the apparatus free of dirt, enclosed it to prevent accidents and put it under the supervision of a competent man.

The logic of this arrangement was so apparent that it is carried over into the design of today's individual conversion equipment. We have said to ourselves, "If it is desirable to provide a motor room for a conversion unit for a 5-stand tandem cold mill so that the unit may be protected against dirty air and against abuse, isn't it just as logical to provide similar attention for smaller spot conversion units?" In other words, the present concept of the variable speed drive did not evolve solely from our own engineers; we had only to recognize the "handwriting on the wall." One or two hp variable speed drives may be a long way from a 10,000 kw motor generator set in a motor room, but the "packaging" you have suggested has helped make the drive a success.

The basic principle employed in the spot conversion variable speed drive is variable voltage direct current, commonly known as the Ward-Leonard system. The basic elements of this system are four in number: (1) a unit to convert alternating to direct current, (2) a source of excitation which can be controlled for obtaining a variable d-c voltage, (3) a d-c motor receiving power from the conversion unit and (4) suitable control for starting, stopping, and controlling the speed of the motor.

The conventional type of conversion unit uses a squirrel cage induction or synchronous motor to drive a regular d-c generator. The source of excitation is a d-c generator driven at constant speed by the main drive motor and supplying excitation to both the main generator and the d-c motor driving the mill or other piece of machinery. The output voltage of the main

Figure 6 — When motor field control is used, constant horsepower is obtained since the torque varies inversely with the speed.



generator is varied by rheostatic control of the excitation.

Another type of spot conversion equipment has recently been introduced which makes use of electronic equipment. The conversion unit is a grid controlled rectifier, the output of which is supplied directly to the armatures of the d-c motor driving the mill or machine. The excitation is supplied by another rectifier. This may be non-controlled rectification, with the excitation voltage controlled by a rheostat in the output circuit of the rectifier, or it may be grid-controlled rectification, giving controlled output voltage.

Adjustable speed from variable voltage, spot conversion, variable speed drive is based upon the fact that a d-c motor supplied with constant excitation for its fields will vary in speed directly with the voltage supplied to its armature, minus the IR drop in the resistance of the circuit and motor armatures. The system has been used for years on large and expensive machines where precise speed control was an important operating consideration. Typical examples are paper machine and steel mill main drives. An important feature of the variable voltage drive is that several d-c motors may be operated from the same conversion unit, each with speed characteristics approximately identical. This principle has been widely used in connection with tandem mills. Individual motors on each of the mills are controlled together to maintain the speed of all sections in approximately constant relationship.

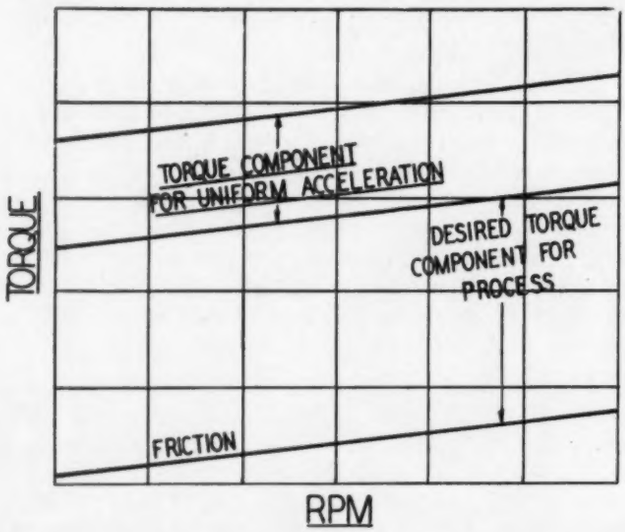


Figure 7 — If uniform acceleration is required, the torque must increase, because the friction torque increases with the speed.

As a matter of fact, the many modifications and refinements possible with a system of variable voltage give it a wide range of usefulness.

SPEED RANGE

In its simplest form the useful speed range of 10:1 with satisfactory operating characteristics is readily obtainable. Over this range of speed, the torque characteristics are such that the d-c motor is capable of producing a constant output torque. The principal limitation toward extending this speed range with the simplest type of equipment is that at low speeds, the speed change of the motor from no load to full load will be a relatively large percentage of full load speed. See Figure 2. This, however, can quite readily be improved and the range of usefulness increased to 20:1 or possibly 30:1 by including regulating means or what is known as IR drop compensation to reduce the speed drop between no load and full load at low speeds. The motor is still capable of maintaining constant output torque although at very low speeds heating would prevent delivery of this torque continuously unless auxiliary ventilation is supplied. Where this is a necessary consideration, auxiliary ventilation can readily be applied.

With the electronic conversion equipment, IR drop compensation can be included readily in the voltage control circuit and the normal electronic drive will give satisfactory operation by voltage control over a range of 15:1. Here again a wider range can be secured by additional refinement in the regulating means.

In either method the speed range can be extended by introducing field weakening control of the d-c motor to get speeds higher than obtained at full operating voltage and with full field strength of the motor. An extension of 2:1, 3:1, or 4:1 in the speed range can sometimes be secured. The principal limitation is usually the top operating speed permissible with the motor.

Over the range of speeds secured by motor field weakening, a motor is capable of producing a constant horsepower output since its output torque varies inversely with its speed. An example of this wide range of speed control is the cold reduction mill. Satisfactory operation must be secured at 50 feet per minute for threading purposes on a machine that may have a top speed of 4000 feet per minute, or a total speed range of 80:1. In this case, a speed range made possible by voltage control with IR drop compensation would be on the order of 25:1 for satisfactory operation at the low threading speed. An additional speed range of approximately 3.2:1 could be obtained by motor field weakening control, giving a total range of speed of 80:1.

ACCELERATION AND DECELERATION

One of the most important characteristics of variable voltage drives is the control of the rate of acceleration and deceleration which is so readily possible. The increments of acceleration and deceleration can readily be made small thereby producing smooth changes up or down as well as providing a wide selectivity of permissible operating speeds.

As the speed of machines and of processing material have increased, it has become important that neither machine nor material be damaged during the accelerating or decelerating periods. In both rotating and electronic systems, the output voltage of the conversion unit is usually controlled through a rheostat handling relatively small current. In the rotating system, the rheostat may handle either the field current or the generator or, if this is too large for economic consideration, the field current of the generator's exciter. In either case it is a matter of a very few amperes. In the electronic system, the rheostat will handle the current in the grid circuit

of the grid control rectifiers which is a matter of milliamperes.

The important point is that a rheostat to handle small currents can readily be built with a multiplicity of steps, thereby giving small increments in speed change between steps. Furthermore, the rheostat may be either manually or motor-operated so that the rate of change and, therefore, the rate of acceleration or deceleration, is conveniently controllable within wide limits. Here again a good example is the cold reduction mill.

In acceleration, the important consideration is that it be smooth and relatively fast. It is frequently accomplished with a motor-driven rheostat containing as many as 120 steps or increments of speed change, and with an acceleration time of from 8 to 10 seconds.

In normal deceleration, the process is simply reversed. However, in the event of an emergency the important consideration is to stop as quickly as practicable to reduce the possibility of marking the rolls and to reduce the amount of scrap. In this case an emergency stop will provide regenerative braking either into the generator, or a resistor, or both which still gives a smooth deceleration but reduces the time of deceleration to the order of 2 to 4 seconds from maximum speed to stop.

Frequently, a further requirement in processing material is that the web of material be maintained under tension during acceleration and deceleration, with the tension controlled to approximately the same value as is to be maintained during normal running. Here again this involves introducing regulating means to control tension during normal operation, and to modify this tension control to compensate for inertia or WR^2 of the machine in supplying the necessary torque for acceleration and deceleration. For example, in accelerating a machine of large WR^2 which is processing a web of material, two increments of torque must be provided, the torque required to process or maintain tension in the material and the torque required to accelerate the inertia or WR^2 of the machine. Once the machine has reached its operating speed, the torque requirement is simply that required to overcome the friction of the machine and process the material. This is accomplished by introducing into the regulating means a compensation on increment of torque for acceleration added to the torque required for operating the machine and processing the material.

SYNCHRONIZATION

When a machine has a motor drive consisting of two or more motors driving various of its parts or components, it is usually necessary that the speeds of the individual motors be synchronized so that they maintain a uniform speed relationship at all times. Inherently the characteristics of variable voltage provide for approximate synchronization over the range of voltage control. Several degrees of refinement can be included depending upon requirements. Where a close approximation rather than an absolute speed synchronization is all that is required, introduction of IR drop compensation in the individual motors is frequently all that is needed.

Where the torque requirement of the processing material is large, relative to the frictional torque requirements of the machine, regulation through current control of the individual motors may be entirely adequate. However, when the torque requirement of the processing material is small compared with the frictional requirements of the machine, and a continuous web of material is being processed, then absolute synchronization with actual motor speed as a reference is usually required. An example of this is the continuous annealing line. By using as a reference the speed of a master section, several regulating means can be introduced so that the speeds of individual motors bear an absolutely constant relation to that of the reference speed. Likewise, compensation may be introduced to change the ratio to be maintained between the speed of the individual motor and the reference speed. Such compensation may be necessary because of gauge change or thermal expansion.

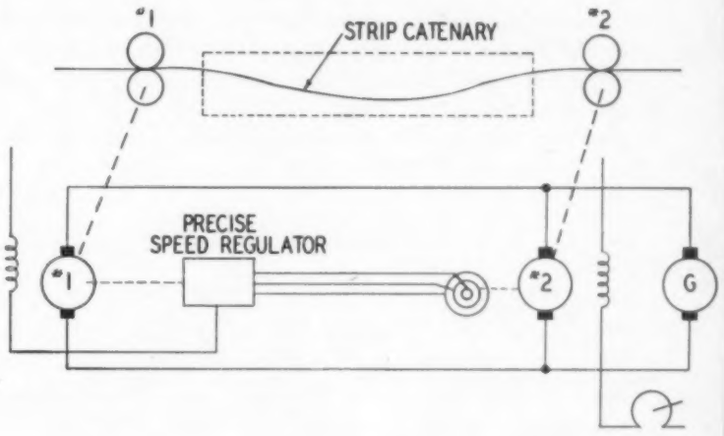


Figure 8 — Speed regulation of strip becomes more difficult as the ratio of the friction load of the machine to the torque requirement of the material becomes greater.

CONTROL CHARACTERISTICS

The variable voltage system may be amplified to include controlled characteristics of various degrees and various types. Basically, these fall in four classifications, control of (1) current, (2) voltage, (3) speed, or (4) rate of change of speed. It is largely in the precise control of these four elements that electronic regulators, rotating regulators, or instrument type regulators are used.

An interesting development is the use of electronic control with rotating conversion units to secure precise control in equipment involving substantial amounts of power. For example, with electronic control of excitation for rotating conversion machines, the rate of control of

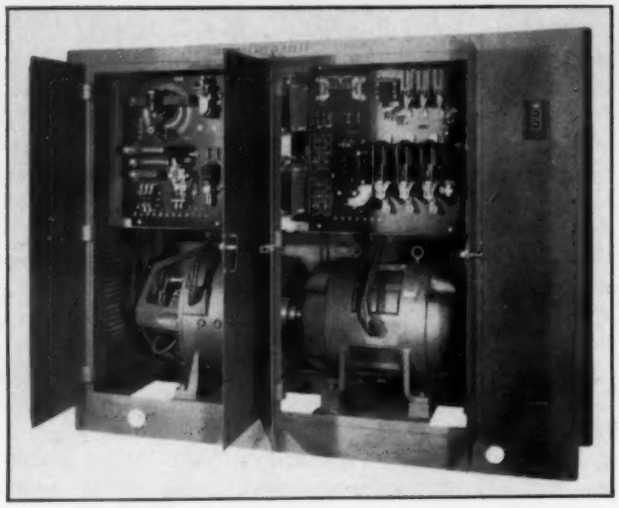


Figure 9 — Spot conversion equipment can be supplied in a package unit.

acceleration may be a function of time, or current, or of the linear relationship of change of speed to time. Sequence operation or programming in which an operating cycle for a machine may be set up in advance and performed automatically, is readily obtainable.

TYPICAL APPLICATIONS

The wide range of usefulness of variable voltage drives is not necessarily confined to the larger and better known applications, such as hot strip mills and cold reduction mills. Other applications, and the particular characteristics of the variable voltage system should certainly include the following:

1. Multi motor wire blocks. Smooth acceleration and deceleration, tension control, synchronization.
2. Blast furnace skip hoist. Speed range in increments and, in some cases, precise speed control.
3. Sintering plants for combining various quantities of different ingredients. Speed range in small increments with adjustment of speed of individual motors so that the ratio of the component in the mixture can be controlled and maintained.
4. Slitting, trimming and processing lines. Synchronization of the various parts of the machine to obtain high operating speed and uniform quality of the product.
5. Electroplating lines. Speed range, acceleration and deceleration, current control, speed control synchronization, and ratio control.
6. Roll grinders. Speed range, and close increments of speed control.
7. Draw bench. Speed range with low "hook-on" speed and smooth acceleration.
8. Runout and conveyor tables. Speed range to match mill or process, frequent start-stop and reversing.

MISCELLANEOUS

One of the considerations which frequently develops as a result of experience with the great range and flexibility provided by variable voltage drives is the simplification of machine design through the elimination of gears, belts, pulleys, and clutches. An outstanding example in the steel industry is tension winding where with older types of drives some sort of speed changing such as a slip clutch had to be provided to compensate for coil build up as well as lineal speed change. In machine tools, a multiplicity of gear changes has in many cases been entirely eliminated or reduced to a single gear change.

CONCLUSION

Increased production has been achieved in a number of ways. One, of course, has been through the ability with a variable voltage drive to operate at the optimum speed. Others have come about through the reduction in set-up time, through the ease of speed selection and speed change, and through the close control of acceleration and deceleration which is possible with this type of drive. Production has also been increased by these "spot conversion" units through the flexibility they have introduced into plant layout and arrangement of equipment.

A much superior job of plant layout, for example, can be done when spot conversion rather than d-c distribution is the accepted means of securing adjustable speeds. When it is necessary to distribute only a-c power, a completely adequate job can be done to cover all sections of the plant. From then on the location or re-

Figure 10 — The package unit principle enables shipping the unit from one job to another.

location of machinery and equipment can be handled without concern for the availability of power. In other words, the flow of material and other purely production considerations can be the determining factors.

The ability to install spot conversion equipment at the point of use has largely influenced its design. Proper enclosures, provision for filtered ventilation, ease of installation and special provisions for maintenance have all been influencing factors. Provision in special cases for building the equipment into the machine itself has also been an influencing factor in its design.

The most satisfactory "package" has been found to be a cabinet ventilated with clean air through filters by a fan operated as an integral part of the variable voltage equipment. The enclosure is under pressure which tends to exclude dirt quite in the same manner as the atmosphere is maintained in a motor room.

The spot conversion unit in the base of the enclosure is factory-assembled with the control and all interwiring completed. The a-c contactor for establishing connection to the a-c power source is within the enclosure as well as the various relays and resistors required for the variable voltage control of the conversion unit itself. It is literally a packaged item which can be placed on the "spot" most convenient to the machine it is to serve. Its nicety of performance is comparable with that of a 10,000 kw motor generator set in a motor room. Certain design features have reduced the number of control items and the number of moving parts.

Whether the spot conversion variable speed unit be the rotating or electronic type makes little or no difference to the logic of its use, although, as has already been indicated, one is better than the other for certain applications.

The most important consideration is that the variable speed drive as a packaged spot conversion unit minimizes the engineering to be supplied by the user and at the same time reduces greatly the installation cost. From a maintenance standpoint its costs are again reduced, due to the accessibility of the entire unit and the fact that it is mechanically protected from injury.

From an appearance standpoint, the engineering approach has paid its respects to precedent wherever possible. The general acceptance in the industry of metal-clad switch gear, dead front controllers of all descriptions and enclosed apparatus was the guide for the enclosure provided on the variable speed drive. Whether it be a 1 hp or a 200 hp drive, it has been made equally pleasing in appearance and ability to blend harmoniously with the machine it serves or the background of the mill.

Because the spot conversion unit built as a variable speed drive can be moved from "job" to "job" as the changing requirements of production may dictate, frequently a complete rearrangement of a mill in the interest of streamlined production can be achieved without any loss of installation dollars for the electrical interconnections between the converting unit and the control.

DISCUSSION

PRESENTED BY

J. R. ERBE, Industrial Engineer, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

H. W. POOLE, Engineer, Steel Mill Division, Industrial Engineering Division, General Electric Company, Schenectady, New York

J. R. Erbe: I do not think we need particularly to discuss variable voltage drives, as such, any further; but I would like to mention some other factors. One is that with the use of variable voltage drives, it becomes possible to keep machines in synchronization, although they may have widely varying inertia loads. I think that a good example of this is shown by some high-speed electric tinning lines where the tension reels, with a 30,000 pound coil, are synchronized with 8-inch diameter back-up rolls and stay in synchronization during acceleration under normal operating process. At the same time, by using variable voltage control on these lines, although they operate or can operate at 1200 feet a minute, they have and can be operated equally well at about ninety feet a minute on zinc plate.

Another definite advantage where the variable voltage drive becomes more or less essential is on other high-speed applications, such as high-speed shears, where it is necessary to accelerate in a minimum of time without time for any controller contactors to operate. A variable voltage drive is a very useful tool for such applications.

H. W. Poole: I well remember a meeting approximately five years ago when, after the presentation of a paper on processing lines, the question was asked during the discussion, "When do you use Ward-Leonard control, and when do you not?" The offhand answer made at that time was, "Everywhere." I think it is even more true today than it was then.

Mention was made of reduced voltage operation, that is, continuous reduced voltage operation and the lack of proper ventilation of the motors because of their reduced inherent ventilating ability. This is something that sometimes is overlooked because, in dealing with such large drives as cold strip mills which are inherently forced-ventilated, the problem doesn't even enter your mind. In dealing with processing lines and similar equipment, however, proper consideration must be given to the problem.

One method of getting by the problem of reduced inherent ventilation was shown to be by the use of blowers and filters. One other method that is sometimes used is to apply over-sized motors which will then carry the required torque at reduced speeds.

The use of speed regulators for holding loops was discussed. The particular instance shown was a catenary loop in a furnace. As we all know, speed regulators are not 100 per cent accurate, and when you are holding a catenary loop with a speed regulator, any inaccuracy,

no matter how small, is cumulative, so that eventually the regulator is going to require readjustment.

An alternate method was tried a couple of years ago by the application of a tension regulator on a catenary loop. It had some advantages and some disadvantages, but if the range is not too wide, that is, the range of products and the range of tensions, you can do a good job of holding a catenary loop by regulating the tension in the strip.

Mention was also made that one type of spot conversion equipment was electronic. I thought you might be interested in knowing what has been done recently and what is now being done in the field of electronic motor control for spot conversion.

Not too long ago, a 40 horsepower electronic motor control was built and installed on a wire drawing machine. At the present time a 350 horsepower electronic adjustable voltage motor control is being built, and also on the designing board are two large rectifiers, 1500 kilowatts and 4000 kilowatts, respectively, which will supply adjustable voltage power to some multi-stand, continuous tube reducing mills.

There is just one thing that I would like to suggest that the authors comment upon. In the first part of their paper, they made mention of the fact that a 35 per cent reduction taken on 0.040 in. material at 1000 feet per minute would require less power than the same 35 per cent reduction on 0.125 in. material at the same 1000 feet a minute, but that this could conveniently be taken care of by the use of adjustable voltage control.

I think that the wrong impression may have been created. The point is that the problem can be met successfully by adjustable voltage plus motor shunt field control.

ADJUSTABLE VOLTAGE DRIVES HELP SPEED AUXILIARY EQUIPMENT

. . . . many processes in the steel industry, requiring coordination of a succession of operations, can be speeded up materially through variable voltage drives in spot conversion units . . . .

by George A. Kaufman

CHIEF ELECTRICAL ENGINEER

JONES & LAUGHLIN STEEL CORPORATION

PITTSBURGH, PENNSYLVANIA

▲ WE are all increasingly aware that production costs have climbed and are continuing to climb in all lines of business today. When there was a war emergency to meet, there was no disposition to quarrel about overtime at time and a half and double time, for the output of war materials had to be speeded up, whatever the cost.

Now the war is won. The emergency which justified a disregard of costs has passed. Industry is on its own. And, while industry hasn't begun to satisfy the pent-up civilian demand for everything from automobiles to zippers, it knows that it cannot make and sell products at a loss and continue to stay in business. That puts it squarely up to everyone who has anything to do with production to give a lot more intelligent attention to costs of operation than ever before. It puts a premium on spending money to save money.

The first cost of new equipment or new methods, which sometimes was what delayed their adoption, is no longer the obstacle it once was to securing approval of changes which hold reasonable promise of reducing the final cost of making the product.

Three factors which loom large in the cost of making steel are labor, materials and machines. Labor cost is higher. The cost of materials is going up. This leaves machines as the one place to improve costs.

There was a time when the choice of electrical drive for a new temper mill or a pickle line or wire mill hinged as much as anything else on whether the installed capacity of the existing d-c shop circuits was sufficient to handle the additional load. If the capacity was there (and in most steel plants it generally was) constant potential motors with magnetic control were almost sure to be specified without further discussion.

It wasn't that steel mill engineers weren't familiar in general with the operating characteristics of variable voltage motor drives. The Ward-Leonard system of control as applied to very large mill motor drives was well known and its advantages well established. There, because of the large quantities of power required, the

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choice of variable voltage drives, with the necessary motor generator sets and Ward-Leonard controls, involved purchases of electrical equipment which in that form or another would have been required in any case to supply the kilowatts required to operate the mill drives.

Where the much smaller motors required for process lines were concerned, for a long time no one thought the extra expense of motor-generator sets, etc., required with variable voltage drives could be justified. That was before we had learned how much more tonnage we could get through the same equipment by using the variable voltage type of drive.

Here are the advantages that made the increased tonnage possible with the use of a variable voltage system:

1. The increased range of speed made possible on process lines which require certain operations at low speeds and others at high speed. With the constant potential system, the range of speed possible with field and armature control is approximately 5:1, while with the Ward-Leonard system, ranges up to 40 to 1 are common and still greater ranges can be obtained.

   This means a unit, for example, a trimming line, can be threaded at 100 fpm and run at 1800 fpm, or the entry end of a pickle line can be run at 50 fpm for spotting at the shear, welder and stitcher and the body of the coil run out at 750 fpm.

   Also, in the case of multiple wire blocks, the same machine can be used to draw one size and kind of wire at 200 fpm and another size or kind at 1200 fpm.

   This range of operating speed made possible with a variable voltage system is probably its greatest advantage.
2. Constant tension control, used primarily in our strip processing machines for reels and uncoilers.
3. Loop control, used in our flying shears, trimmer, or other units where a minimum of tension is desired.
4. Acceleration and deceleration of a unit for a predetermined requirement. Two important examples are:
   a. Constant rate of acceleration at a fixed time, used on most applications, usually by means of a motor operated rheostat on the generator.
   b. Current limit control which accelerates the unit at the maximum possible speed for the load condition at that instant.

      Examples here are, skip hoist control, screwdown control, pickle line control.
5. Synchronization of drive motors. Here any line that has more than two motors that must operate together over a variable speed is an example. It can be done occasionally with constant voltage drive, but only at low line speeds.
6. The simplicity of operation of a variable voltage drive with its minimum of adjustments has freed the operator on many of our process lines so that he has more time to watch quality, and control quality of product.

   Our shear lines are prime examples of this advantage. With variable voltage control and automatic loop control, the operator is no longer tied to his control bench and can inspect the strip, check sample sheets and in other ways watch the quality operation of the line.

The following is a list of major items to which we have applied variable voltage drives in the majority of cases, despite the fact that a d-c shop source was available for constant voltage drives.

1. Trimming lines.
2. Shearing lines (sometimes, combination of 1 and 2).
3. Pickle lines.
4. Multiple wire blocks.
5. Electro-tinning lines.
6. Electro-cleaning lines.
7. Mill screwdowns.

In the more recent installations, part of the cost of the variable voltage installation was covered by the cost of the required additional constant potential capacity that would have had to be installed if constant voltage drives had been used.

Our experience with variable voltage drives for process lines really dates from 1935, when we installed the first of our electro-cleaning lines at our Aliquippa works. It was intended to handle tin plate and similar products right off a four-high, reversing mill. In fact, the installation of this electro-cleaning line coincided pretty much with the start of dismantling of our old hot mills.

A brief resume of the changes we made in this electro-cleaning line — and in a second and a third line installed later — should serve as a first rate example of how we found it possible to justify a series of changes in motor drives as each increase in speed paid off in a reduced cost per ton of finished product.

Because of the availability of plenty of d-c from shop circuits, constant potential motors were first applied to the No. 1 line and a top speed of 400 feet per minute achieved. The d-c load on the job was between 75 and 100 horsepower at 250 volts.

A second electro-cleaning line installed two years later went in as a variable voltage or "spot conversion" installation at the very outset. Our ability to get higher speed and more tonnage from this new line which operated at 800 fpm was so apparent that it led in 1940 to a revamping of the first line, to a speed of 800 fpm. In addition to the increased output directly attributable to the increase in speed, there was an appreciable gain resulting from the smoother, quicker acceleration, and deceleration possible with the new drive.

Speed of the No. 2 line was likewise increased during this period. The line was brought from its original 800 feet per minute to 1200 feet per minute by increasing the size of the motor generator set from 50 to 75 kw and adding a 7½ kw drag generator on the entering end of the line.

In each case, the increase in output with increase in speed was more than enough to offset the cost of the electrical equipment and controls involved in the change-over to larger "spot conversion" facilities.

A third electro-cleaning line installed in 1939 was likewise equipped from the outset with Ward-Leonard controlled motors, for a speed of 1250 fpm at 250 volts; these two lines No. 2 and No. 3 now handle our entire tin plate production and are operating at a speed of 1500 to 1800 fpm by increased voltage on generator.

These results, as you can understand, have so far exceeded expectations that even those who at first opposed the introduction of variable voltage or "spot

conversion" are now its staunchest advocates. In fact, today, no one in our plant would think of equipping these lines with anything but "spot conversion" units.

TEMPER MILL SPEED-UP

Two temper mills installed in 1936-7 were equipped at the outset with variable voltage or "spot conversion" motor drives. So well did this type of drive perform that from a top speed of 1200 fpm ten years ago, the equipment is now being operated at 3750 fpm. The changes which were made to obtain this more than 300 per cent increase in speed should be of interest.

The original "spot conversion" installation for each of the two mills consisted of a 500 kw motor generator set with Ward-Leonard control to supply energy at 250 volts d-c to a 250 horsepower, 250/375 rpm mill motor; a 200 horsepower, 250/375 rpm puller motor; and a 125 horsepower, 300/1200 rpm tension reel motor.

Other electrical equipment included two 15 kw drag generators per mill, a 28.4 kw, 63 volt auxiliary motor generator set; a 28.4 kw, 32 volt puller motor booster; and a 7.5 kw, 63 volt feed reel booster.

With this equipment, the mill operated at a top speed of 1200 feet per minute. Acceleration and deceleration were achieved so smoothly, however, that it wasn't long before someone asked why it wasn't possible to operate at an even higher speed.

With 2000 fpm as a goal, the speed range of the main driving motor was increased to 260/413 rpm, and that of the puller motor was raised to 300/477 rpm. A 60 kw, 63 volt puller motor booster replaced the 28.4 kw unit and new double acting regulators and a new counter emf exciter were added to the two drag generators on each mill. The gear ratio of the tension reel motor was changed from 4.1/1 to 3.15/1.

These changes added approximately 10 per cent to the cost of the original installation. They produced the desired increase in operating speed, however, and an increase in tonnage of much greater proportion than the increase in cost.

Under the circumstances, it wasn't too long before another speed-up was proposed, this time to 2500 fpm

The mill motor was left the same as before, except that its control was arranged for operation from 375 to 550 rpm. The puller motor was speeded up to 450/630 rpm.

The tension reel motor was also doubled in size, to 250 hp and speeded up to 400/1600 rpm at 250 volts, with new gear ratio of 2.62:1, the drag generators were direct connected, and changed to 30 kw 150/600 rpm.

These changes again added approximately 20 per cent to the original cost of the two mill drives. However, the increased speed made possible enough more tonnage output to again warrant the cost.

A fourth speed-up of these tandem mill drives has now been completed to bring them up to 3750 feet per minute. To accomplish it has required the purchase of new 30 kw booster generators for each mill, drag generators, a change in gear ratio on tension reel motors from 2.62/1 to 1.9/1 and a change from 20 inches to 16 inches in the inside diameter of the wind-up coil.

Whether we have obtained the last possible increase in speed out of these particular mills, I am not able to say at this time. All that I do know for a fact is that these increases in rate of operation which have paid such handsome dividends would not have been possible, except for the flexibility of operation and ease of control which is associated with the variable voltage or "spot conversion" type of drive.

We have had to admit that we had succeeded in increasing our useful range of operating speeds on our electro-cleaning lines, our temper mills, and our wire blocks beyond anything which could be duplicated with constant potential drives. Control of armature and field currents by ordinary methods simply would not have given us the same results that the Ward-Leonard system of voltage control, using motor generator sets, did so neatly. With this the case, it became rather academic to try and draw any conclusions from a direct comparison of overall costs between d-c distribution with constant potential motor drives, and a-c distribution with "spot conversion" equipment and variable voltage drives.

The cost of electric power per ton of processed steel is in most instances an insignificant part of the total cost. Consequently, it is in the initial cost of the equipment and installation, plus its maintenance cost with which we must be primarily concerned.

The fact that in "spot conversion" we may have several motor generator or rectifier sets operating from a-c distribution instead of a single generating source feeding the d-c distribution of a shop is not too important from the point of view of overall electrical efficiency. It is important, however, from the point of view of loss of production should the single power source fail, as opposed to the failure of only one of the many power sources represented by the "spot conversion" units.

Here is a somewhat different situation. We have around 15 or 20 old wire blocks which are still operated with constant potential motors run off the 250 volt shop circuit. We have in mind installing "spot conversion" units on these wire blocks to shift the load to our a-c distribution and release the equivalent 250 volt d-c shop circuit capacity to take care of other machines where "spot conversion" is not so essential. Here is one of the few instances where a fully loaded shop circuit has been a factor in determining the type of motor drive to install. In this case, we can spend the money to improve these wire blocks because we save it by not having to increase shop circuit capacity.

Today at Jones and Laughlin, we are looking askance at every operation not using "spot conversion." We are studying the cost of replacement now, or when repairs to present equipment will justify it, of almost all constant potential motor drives.

In fact, cranes are one of the few pieces of equipment which we are sure we would leave equipped with constant potential drives, and the controlling reason here is not converned with the electrical characteristics of the drive but with the weight of the "spot conversion" equipment which would be prohibitive to carry on the crane structure.

In the final analysis, it is probably because most processes in the steel business lend themselves so well to the coordination of a succession of operations that they are such a "natural" for variable voltage drives.

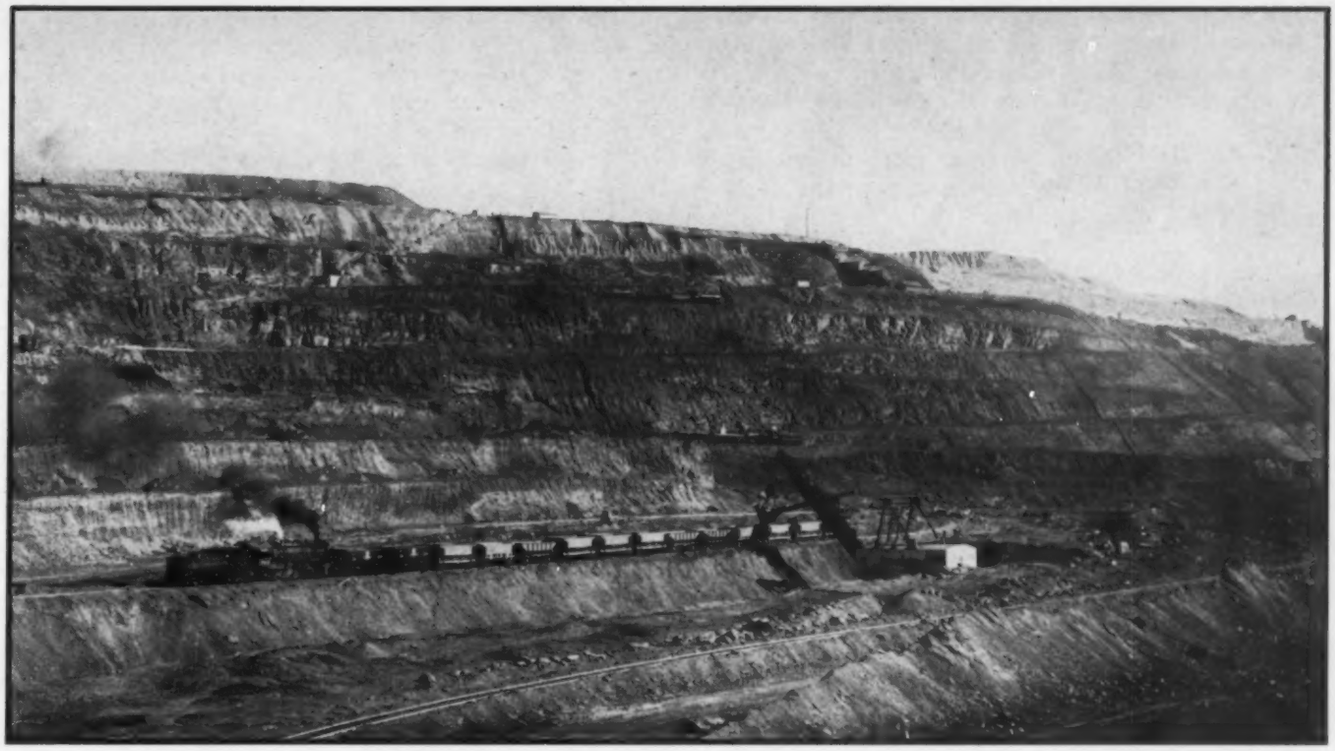

Figure 1 — The Hull-Rust iron ore mine at Hibbing, Minnesota, is an example of the large open pit mines in the Mesabi range.

IRON ORE RESERVES OF *The Mesabi Range*

by E. W. Davis, DIRECTOR, MINES EXPERIMENT STATION
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. . . . much concern has been expressed as to the early depletion of the low cost, high grade iron ores . . . . however, the taconites now known to exist will provide a practically inexhaustible supply, once an economical method for processing is developed . . . .

▲ THIS nation has been depending upon the Mesabi Iron range in Minnesota for the larger portion of its iron ore requirements for nearly half a century. Furthermore it can continue to draw the major portion of its ore requirements from the same source for another century or more, but to accomplish this, great changes must take place in the present ore mining industry. Preliminary preparations for these changes are now underway and in the next few years, decisions of far reaching importance must be made. To understand the situation, it is first necessary to know something of the geology of the Mesabi iron formation.

Presented before AISE Annual Convention, Cleveland, Ohio, October 4, 1946.

Compared with other mining districts, the geological formations making up the Mesabi Iron range are very simple. The Mesabi iron formation is composed of a type of rock called taconite, containing about 30 per cent Fe and 50 per cent SiO_2. This formation stretches across northern Minnesota in a continuous sheet 100 miles long and several hundred feet thick. This sheet lies on top of the Giants range granites and was deposited there, perhaps by a combination of chemical and bacterial action, very early in the geological history of the world before any type of life existed except possibly bacteria life. The iron formation was deposited as a sheet of silt in the bottom of a shallow sea, and this sheet still slopes gently downward at an angle of only about 5 degrees toward the southeast. On top of this layer of iron-bearing silt, other silts containing little or no iron were deposited. Time, pressure, and perhaps heat, have consolidated these silts into hard rocks. As it occurs now, the iron formation is about 600 feet thick, and is hard, solid rock having an irregular banded appearance caused by changes in the mineral constituent.

After these silts were deposited and consolidated, many geological events occurred which altered the

nature of the iron minerals, but fortunately for us, there was no radical ground movement in this district. In many of our iron ore mining districts, ground movement has bent, twisted, and deformed the iron ore deposits until they are discontinuous and stand, more or less, on edge. In some places they have been bent backward upon themselves and more or less mixed with other rock. In other places molten rocks have been intruded into them, breaking them up and altering them both chemically and physically.

The only major structural change in the Mesabi district appears to have been caused by the comparatively recent action of the glaciers that moved over this country in a general direction from north to south. These great ice sheets scoured out the rocks as they moved southward and deposited glacial debris of various thickness as they melted and receded. However, the rocks making up the iron formation of the Mesabi were very hard, and the glaciers tended to pass over the top of them with a minimum of scouring. As we find the iron formation now, the northern edge has been planed off by the glaciers and cleared of the original sedimentary rocks that covered it. In place of these rocks the glacier deposited sand and gravel, in some places a few feet thick, and in other places several hundred feet thick. This has left a wedge-shaped section of the iron formation covered only by glacial debris. Beyond this to the south, the formation slowly dips downward under the overlying sedimentary rocks and their covering of glacial drift.

Figure I shows a cross section of the Mesabi iron formation. The wedge-shaped section of the formation which is covered only by glacial drift is from one to three miles wide and extends the full 100-mile length of the range. At the northern boundary the wedge has practically no thickness, but at the southern boundary where the overlying sedimentary rocks appear, it is the full 600 feet in thickness.

As previously mentioned, this iron formation of the Mesabi is very low grade, containing only about 30 per cent Fe. Most of this iron occurs as very fine grains of magnetite and hematite, finely disseminated throughout the rock mass. If this rock, which is called taconite, is ground fine enough, the grains of iron oxide can be removed in a fairly pure state. The amount of this taconite that is covered by glacial drift only is enormous, recorded in the scores of billions of tons, and if any reasonable portion of the formation that dips under the sedimentary rocks is included in the tonnage estimates, the amount becomes almost astronomical.

If this taconite constituted the whole resource of the district, the iron and steel industry would have had very little interest in the Mesabi, but here and there, throughout much of the length of the exposed portion of the formation, the action of percolating water over long periods of time has softened the formation and actually dissolved out much of the silica which it originally contained, leaving only the high grade, iron oxide behind. These troughs and pockets, where extensive leaching has occurred, vary enormously in size, from a few square feet up to the great area around Hibbing, from which hundreds of millions of tons of high grade ore have been removed.

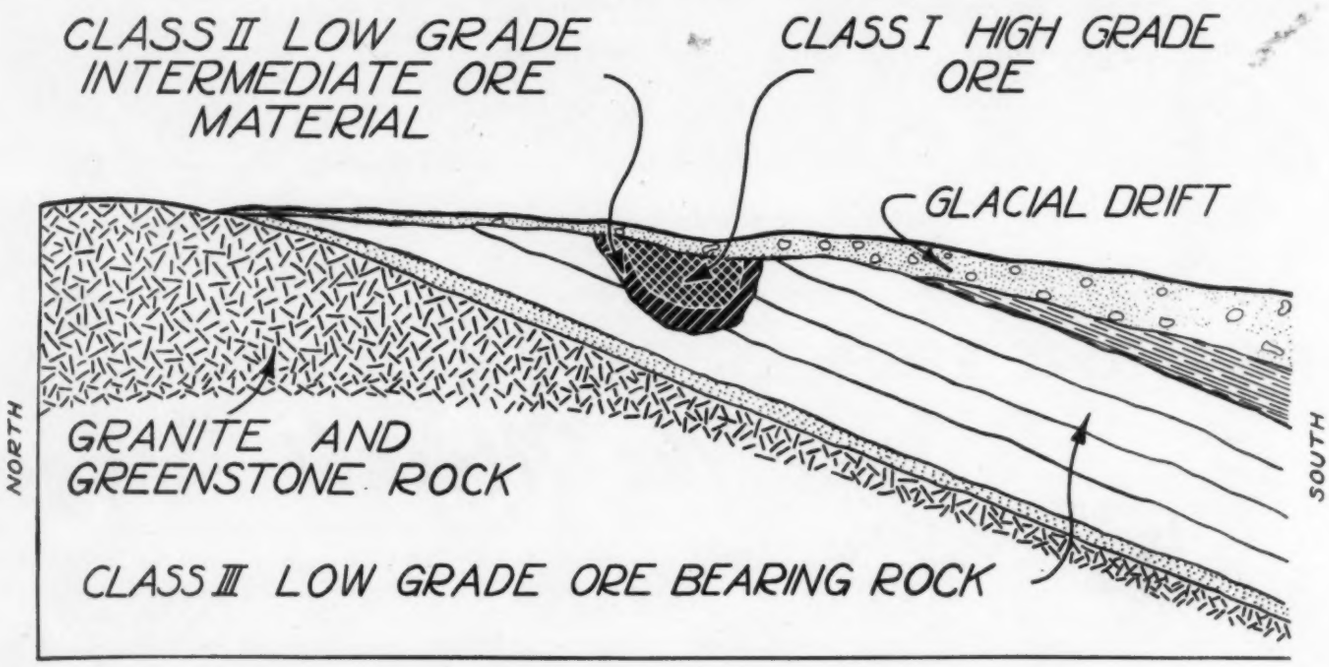

Figure 1 — Generalized cross section of the iron formation of the Mesabi range.

From these leached areas found here and there along the range, over a billion tons of iron ore have been removed during the last 50 years. The average analysis of this ore has been 51.81 per cent Fe, 7.61 per cent SiO_2, and 0.062 per cent P. Most of the ore has come from the open pit mines where the glacial drift is thin enough and the leached area large enough to make stripping operations profitable, but a considerable portion had been secured from underground mines where the surface was too thick to strip. Another large source of shipping ore has been the concentrate produced largely toward the western end of the range. Here the leaching action which formed the high grade ore around Hibbing has not progressed to completion, resulting in the formation of an ore material intermediate between the taconite of the iron formation and the high grade direct shipping ore. By crushing, washing, jigging, etc., it is possible to enrich this type of material so that it also can be shipped to the blast furnace. Many concentrating plants have been operating on this type of material for many years and normally

provide 10 to 15 million tons of shipping ore per year.

The actual tonnages that have been produced from these three sources of ore during the life of the Mesabi are shown in the accompanying table.

Total Ore Shipped from the Mesabi

Classification	Tonnage
Open pit direct shipping	963,556,000
Underground direct shipping	265,783,000
Concentrates	207,147,000
Total	1,436,486,000

Up to the present time, only a few thousand tons of taconite concentrate have been produced.

The above information has been given to show the simple geological nature of the Mesabi and the availability of the ore. The deposits of enriched ore are shallow and are easily located by drilling and test pitting. The Mesabi has been explored from one end to the other, and all of the information developed by these explorations is available to the engineers of the Minnesota Tax Commission. This commission has accurate maps of all of the ore deposits on the range, and their estimate of the tonnage of reserve ore is probably much more accurate than estimates made for any other mining district in the world. In view of the simple geological nature of the Mesabi range, and the extensive exploration that has been done, the discovery of any new large bodies of high grade ore is improbable. Most of the mining companies reluctantly gave up this hope many years ago. Some new ore will undoubtedly be discovered since the tonnage estimates computed by the Tax Commission are conservative, but no great discoveries of new ore should be expected in this district.

As great as the Mesabi has been, there is an end to its ore reserves, and since most of our steel industry is based on the smelting of lake ores, the question is often asked "How much longer will the Mesabi last?"

In attempting to find an answer to that question it is necessary to keep certain factors in mind. We know, for example, that there is about a billion tons of ore remaining on the Mesabi of the types now being shipped, and if this figure is divided by an estimated production, say 35 million tons per year, the life of the Mesabi becomes about 30 years. If production is at the rate of 70 million tons per year as it was in 1942, the ore will last only 15 years. No one knows what our future ore requirements will be, but regardless of this, such a simple method of calculation leaves entirely the wrong impression. It must be kept in mind that nearly all of the ore on the Mesabi is owned by various consuming interests and these different interests do not all own ore reserves that are proportional to their annual requirements. While some of the steel companies have reserve ore for perhaps 30 years, others will exhaust their reserve in 5 years or less. Without considering statistics, it is easy to observe that a number of steel companies feel the need for increasing their ore reserves because these companies are actively engaged in attempting to find new reserves in other districts within shipping distances of their existing steel plants. It should be explained that there is no real shortage of iron ore in this part of the world, the only question being from which of several sources can ore be secured at the lowest delivered cost.

With one or two exceptions, nearly all of the steel companies have engineers actively engaged in a search for new ore. Some are working in South America, in Cuba, in Labrador, in New York State, and some are working on the taconites of the Mesabi. These companies would not be so actively engaged in a search for new reserves if they had 20-year ore supplies on the Mesabi as casual statistics might seem to indicate.

The statistics show that most of the remaining Mesabi high grade ore is in the hands of the U. S. Steel Comporation. In the early days their engineers and geologists showed great foresight in acquiring mineral lands. However, the fact that most of the good ore is in the hands of one steel company makes it impossible to answer the question of how much longer the Mesabi will last. Obviously, one after the other, the various steel companies will exhaust their holdings and will have to look elsewhere for new ore, although the U. S. Steel Corporation will undoubtedly be securing their ore from present sources for a great many years.

The tonnage of ore remaining on the Mesabi divided into different classifications is as follows:

Ore Reserves of the Mesabi Range

Classification	Tonnage	1945 Shipments
Open pit direct shipping	486,517,000	42,705,000
Underground direct shipping	339,188,000	1,646,000
Open pit concentrate	102,298,000	13,875,000
Underground concentrate	53,790,000	143,000
Taconite concentrate	very large	none

As shown above, very little underground ore is being produced on the Mesabi. This is because of the high cost and the comparatively slow rate of production. It should also be understood that open pit concentrate, which represents quite large annual shipments, is not sufficiently low in silica to be smelted direct. The average silica content of the concentrate being shipped is approximately 11 per cent, and since the blast furnace operators require an 8½ per cent SiO_2 mixture, it is necessary to mix this concentrate with lower silica material. This low silica material comes from the large, open pit, direct shipping mines, and concentrate can be used only so long as there is high grade ore available to be mixed with it. This brings out the fact that the actual reserves of any steel company are not reflected in the tonnage figures alone. The average shipments from the Lake Superior district for a great many years have not varied a half of one per cent from 8½ per cent SiO_2. Therefore, the real reserve of any company is the amount of ore that they have available that will grade to approximately 8½ per cent SiO_2. A company may own large quantities of concentrating ore, but unless they also control at least an equal tonnage of 4 or 5 per cent SiO_2 ore, the concentrate by itself can hardly be considered an ore reserve for that particular company.

With these facts in mind, it is obvious that the Mesabi reserves of any steel company are governed largely by the amount of open pit, direct shipping ore that this company controls. Since the U. S. Steel Corporation owns over 75 per cent of this material, it is obvious that statistical figures simply showing tonnages may be very misleading.

As previously stated, several of the mining companies, through their mining subsidiaries or agents, are actively engaged in investigating the taconites of the Mesabi range. It is obvious that if the Mesabi is to continue for long to supply the major portion of the iron ore smelted in this country, this iron ore must come from the large quantity of taconite that exists in this district. Several companies have acquired great areas of taconite

Figure 2 — A world's record haul of 18,543 tons of iron ore in one trip down the Great Lakes was established by the ore carrier shown above.

on the range and are actively engaged in developing these properties and studying their concentrating characteristics. If economic methods can be developed for the concentration of this material, these companies will have developed ore reserves for themselves that will last for hundreds of years. On the other hand, if economical methods cannot be developed for the production of taconite concentrate, many of the steel companies must look to foreign sources for their future ore supplies. As far as is known at the present time, the future ore supply of the great steel industry bordering the Great Lakes must come either from taconite or from some foreign sources.

As previously stated, taconite is a hard rock containing between 20 and 35 per cent Fe, largely in the form of fine grains of magnetite or hematite. Great areas exist in which practically all of the iron oxide is in the magnetic state. It is comparatively simple, in the laboratory, to crush this type of material to a fine size, and by the use of magnetic separators, produce concentrate assaying 8 per cent SiO_2 or less. When the iron oxide is in the form of hematite, the separation is not so simple, although experiments are now going forward in a number of laboratories for the development of methods for the concentration of this type of material. Enough work has been done on the concentration of magnetic taconites to give an accurate picture of the type of processing required and the nature and cost of the processing plants.

Magnetic taconite must be mined, crushed, ground to −100 mesh and concentrated in order to produce low silica concentrate. This fine concentrate must then be agglomerated before it can be charged into the blast furnace. Since taconite is low in iron, it will be necessary to mine 3 tons of the rock and reject 2 tons as tailing in order to produce one ton of shipping product. It is obvious that in order to make such an operation economical, it must be done in very large plants in which every advantage is taken of the possibility of cost reduction. Actually, a taconite concentrating plant will be quite similar in appearance and layout to the great low grade copper concentrators of the west, but with the addition of an agglomerating plant. While taconite is hard to drill and crush, it is easy to grind because it is brittle and, therefore, breaks readily to a fine powder in rod mills and ball mills. The resistance to grinding of taconite is actually less than for many of the western copper ores which are ground to about the same fineness.

We know, from figures compiled from many sources, that the cost of a taconite plant to produce a million tons of agglomerated ore per year will be about 10 million dollars and we also know that this agglomerated taconite can be produced at a cost only slightly above normal Lake Erie prices. Large scale blast furnace smelting tests, using high grade magnetite sinter, indicate a considerable saving in smelting cost over the cost of smelting normal Lake ore. Therefore, while the cost of producing taconite concentrate may be higher than the present cost of Lake ore, smelting costs will be lower and, therefore, the cost of producing pig iron should not be seriously affected.

As evidence of the accuracy of this statement, it is well known that Bethlehem Steel Company and Youngstown Sheet and Tube Company, through their operating agent, Pickands Mather and Company, have acquired great areas of taconite on the Mesabi and have a laboratory and test plant operating near Hibbing,

Minnesota, concentrating large samples which they are mining from the properties they have acquired. This work has been going on for the past five years and obviously, these companies at least, feel that the expenditures they are making are justified. Oglebay Norton and Company are doing the same type of work in cooperation with American Rolling Mill Company and Wheeling Steel Corporation.

Whether or not the next few years will bring the erection of large taconite plants on the Mesabi remains to be seen, but obviously some of the steel companies feel that such a development is distantly possible. If this development comes, we will have an almost inexhaustible supply of high grade iron ore available within the borders of our own country. The Mesabi range will actually become a manufacturing district rather than a straight mining district because this taconite industry must be looked upon as one that actually manufactures high grade ore from worthless rock. The State of Minnesota has recognized this fact and has modified its tax laws so that the total tax paid by the taconite industry will amount to only about 6 cents per ton of shipping product. This compares with an average tax on the ore now being shipped of about 43 cents per ton of product shipped.

In conclusion, it may be stated that nearly a billion and a half tons of iron ore have been shipped from the Mesabi and about a billion tons of the same type of ore still remains. However, the remaining ore is not divided among the various steel companies according to their requirements, and some of the companies are finding it necessary at the present time to develop new ore reserves. They can probably manufacture all of the good ore they want from the Lake Superior taconites, and these are being very carefully investigated, but if some cheaper source of ore is available, it may not be necessary to go to the expense of processing this low grade material. High grade ores in large quantity are known to exist in Labrador, Cuba, and South America, and if and when a deep St. Lawrence Waterway is constructed, these sources may be available to our northern steel plants. As wage rates increase in this country, the cost of mining and processing low grade ores increases and foreign ores become more attractive. However, dependency upon foreign ores would mean a much larger stockpiling program than at the present time, and this would add to production costs. There are also technical problems involved in the smelting of some of these foreign ores, and political problems have appeared in the past and probably will again in the future, in connection with the ownership and exportation of ore from foreign countries.

These are interesting times in the iron ore industry and decisions of great importance are being made, but it appears certain that the future ore supply of our Northern steel industry will come either from abroad or from the Lake Superior taconites.

DISCUSSION

PRESENTED BY

M. D. HARBAUGH, Lake Superior Iron Ore Association, Cleveland, Ohio

CHARLES E. AGNEW, Consultant, Cleveland, Ohio

E. W. DAVIS, Director, University of Minnesota, Mines Experiment Station, Minneapolis, Minnesota

E. W. SHALLOCK, President, American Ore Reclamation Company, Chicago, Illinois

M. D. Harbaugh: The paper is a clear and simple presentation of the significant facts about the Lake Superior ore situation. Such differences of opinion as exist about the development of production from taconite are mainly on the questions of "when" and at "what cost." The rate of annual demand for ore is the critical fact in the picture. Continuation of high demand such as existed during the war means very rapid drain upon the open pit reserves and consequently rapid exhaustion.

It seems likely that production from taconite will appear on the scene even before the overall ore reserve situation may seem to warrant it, largely because of the fact pointed out by Mr. Davis that reserve supplies available to some consumers are much more limited than are those available to others.

From the amount of attention the problem of taconite concentration is receiving at the hands of the Lake Superior industry, there is reason to believe that production from this source may be initiated within a relatively few years if the steel industry long continues to operate at rates which are indicated by its present operations and by the pent-up demands for its products which are so widely apparent.

Charles E. Agnew: Mr. Davis brought out one point on the grinding cost of the taconite ore which was of particular interest to me. In this part of the country the comment is frequently heard that the grinding cost makes the use of the taconite deposits economically prohibitive. If this comment is erroneous then it appears to be a question of accepting the grinding operation if beneficiation is at all justified. Mr. Davis said the beneficiation of the leaner ores is fast becoming a "must" operation for many of the ore companies.

Many soft ore blast furnace operators are apparently reluctant to accept the fact that the use of fully beneficiated ores calls for some change in furnace practice methods, but it is believed this fact is also a "must" just as the beneficiation of the lean ore is a "must."

Dr. Davis said the justification for beneficiation was frequently determined by the blast furnace operator's desire for 8.00 to 8.50 per cent silica (SiO_2) in the ore. That percentage of silica content in Lake ore mixes has been used throughout the industry for many years as a rough guide for indicating the amount of silica needed to form a slag of a desirable chemical composition. It is believed that the percentage of silica indicated does

not have any virtue in itself, but the relation of that percentage to the percentage of alumina (Al_3O_2) in the normal Lake ore mixes is a satisfactory one. Some blast furnace operators believe the alumina content in the mix can be ignored, but the opinion is offered that in the search for refinements in furnace practice it will be learned the belief cannot be sustained. The ratio of silica to alumina in the coke ash is reasonably constant in any blast furnace mix and it is believed the preferred percentage of silica in the ore will be determined by the percentage needed to properly balance the alumina in the ore, plus the alumina in the coke ash, all of which goes to the slag.

The proper chemical composition of slag is one of the most important phases of blast furnace operation. With the beneficiation of the ore used, the opportunity is presented for providing the slag constituents in the preferred ratios. It must not be forgotten, however, that a change in the character of the ores calls for a change in furnace practice methods, regardless of the method of beneficiation used.

E. W. Davis: The blast furnace people will have to begin experimenting soon if the steel companies are going to go forward with taconite beneficiation, because the small amount of alumina and lime that taconite contains in its natural state is mostly washed out in the processing. Practically nothing is left but iron oxide and silica.

However, some work is being done in connection with the addition of alumina to the fine ore before agglomeration. This may remove some of the objections, if it develops into an economical operation.

You also mentioned something about grinding cost. Many people have had the idea that the cost of grinding taconite is prohibitive, and was the real reason that the Babbitt operation on the east end of the Mesabi had to close down some 25 years ago.

It wasn't nearly as simple as that. It wasn't just that the grinding costs were too high, but most of the other costs were too high, also.

I can tell you this about the grinding cost. Power consumption will be about 12 kilowatt hours per ton. That is the power required to grind a ton of the rock from three-quarters of an inch to the right size for concentration.

At the present time, power costs are about a cent per kwhr. However, if taconite concentration goes ahead, this cost will be materially reduced. If it is not, the operators will build their own power plants because power can be generated up there for something around half a cent per kwhr.

Since the whole taconite operation requires over 60 kilowatt hours per ton of concentrate, a saving of 30 or 40 cents can be made with cheaper power.

One of the largest difficulties in the whole taconite operation was not the grinding but the drilling of the rock. The rock is very hard. As a matter of fact, the glacial scratches made 25,000 years ago are still evident on the surface.

Drilling for blasting purposes was really difficult. They drilled six or eight-inch diameter holes in a row, perhaps fifteen or twenty feet back from a 30-foot face, and shot down the whole face at once.

Standard churn drilling, which is still the best practice was used. If a driller could make one foot an hour, drilling six-inch holes, it was considered good.

Recently, I saw a very interesting demonstration at Babbitt. Using oxygen and petroleum products, holes were being burnt in this hard rock. The operation is a combination of melting and spalling, and they were making six-inch diameter holes at the rate of ten to fifteen feet per hour. I know nothing about the cost, but if they can drill 10 to 15 times as fast as by the older method, a reduction of cost is almost certain.

Another problem that was troublesome in the old days was the agglomeration of the very fine concentrate. Tests are going on now, and at a good size scale, to agglomerate this material in a little different way that should reduce that cost and use to advantage the fact that the concentrate is extremely fine. There is enough encouragement in this development to keep the operating companies very much interested.

E. W. Shallock: We all know, of course, that the beneficiation of the ore is going to be a difficult problem. The rate of sintering will be much lower with the fine materials and, therefore, the cost per ton of sinter will be somewhat higher.

I think that once we get to working on this, on a large scale, we will find ways and means of using the present method of agglomeration to better advantage than ever before.

E. W. Davis: Mr. Shallock had experience in the old Babbitt operation, and he knows all about the sintering difficulties. Much water has gone over the dam since that old operation, and we now know much more about the sintering of fine ore, but we continually meet the statement against taconite concentration that "you can not sinter such fine stuff."

A few years ago we had a sintering demonstration at the University. The demonstration was just to answer that objection.

We used an old method of operation that Lloyd and Greenawalt worked on in the early days. The damp ore was mixed with the fuel and was rolled into pellets or balls and these were put on the sintering machine. When we did this, in effect we were sintering coarse ore and the burning rate was materially increased. The reason I think that the earlier attempt did not succeed was because the people who were working on it did not learn to make good strong balls. It took a lot of study before we learned to roll the ore up into balls that would maintain their shape during the sintering operation, but when this was done the result was more rapid sintering.

Charles E. Agnew: Mr. Davis and Mr. Shallock have both mentioned the difficulty of sintering the very finely ground taconite concentrates. We can accept that. In his paper Mr. Davis said the true ore reserves were the amount of natural ore of a low silica content which were left for mixing with ores of a higher silica content to obtain an average silica content which is acceptable to the trade. If the grinding cost of the taconite is not prohibitive then that material can be carried to a very high degree of low silica, high iron concentration, and the concentrate blended and sintered with the leaner natural ores. I have sintered and used thousands of tons of similar mixtures and it makes a beautiful product.

Composition Bearings . . .

. . . . in addition to their use as roll neck bearings, composition bearings are proving themselves in many other applications . . . .

by W. A. Rankin

GATKE CORPORATION

CHICAGO, ILLINOIS

▲ COMPOSITION bearings no doubt mean roll neck bearings to most steel men. This is natural as the results obtained from composition roll neck bearings have revolutionized many rolling operations. Rather than take up time to discuss requirements with which most steel men are familiar, this paper will present other applications of interest in which moulded fabric bearings are advantageously used.

Water lubrication has also become more or less synonymous with composition bearings. Water is an ideal lubricant and coolant for most roll neck and many other steel mill bearing applications, but the advantageous use of moulded fabric bearings is by no means limited to water lubricated service. In fact, moulded fabric bearings are made which are especially suited to oil or grease-lubricated service. They have many performance quality combinations not ordinarily obtainable in conventional bearings.

The results afforded by moulded fabric slipper bearings, which are grease lubricated, are well known. The severity of service imposed on universal coupling slippers is seldom equalled in any other application for the tremendous power required to drive the mill must be transmitted through the slippers, and under tremendous unit loads, the slippers are slowly rubbed between the socket and the spade. When the mill is reversed or takes up the load, impacts of extreme severity pound the slippers between the socket and the spade.

Worn, scored and battered metal slippers are often removed after limited service. Also, spindles with scored sockets must be removed at a great cost for reconditioning such members. The pounding, vibration and deafening noises caused by worn metal slippers is well-known. Reports on moulded fabric slipper grease-lubricated applications, indicate some typical results as follows:

A superintendent who has used moulded fabric slippers more than six years reports, "Results from all applications are so superior to metal slippers that all new equipment is to be delivered with moulded fabric slipper bearings." The master mechanic in another plant says, "We plan to use only moulded fabric slippers in universal drives. In no location do they give less than four times the life of other slippers, to say nothing of the superior performance of the mills." Another superintendent says, "It would take fifty sets of metal slippers to equal the results we obtain from one set of fabric slippers." All of the universal drives in the plant are now thus equipped. Still another report: "We have not reconditioned a single spindle since installing moulded fabric slippers more than three years ago." These are typical of countless reports covering a period of more than ten years.

Some of these unusual qualities offer a proven solution for many troublesome and costly applications.

Moulded fabric bearings have a compressive strength up to 43,000 psi and yet have a degree of resilience that absorbs shock, dampens vibration, and deadens sound. The same resilience permits accurate conformity to the journal under excessive pressures, thereby avoiding severe localized pressures that rupture the lubrication film, resulting in metal to metal contact, chafing and scoring.

Adequate conformation to the journal is maintained under changing direction of pressure, as well as in the cases of slight misalignment which occurs when the shaft or frame flexes under extreme loads. Since the conformation is achieved through resilience rather than wear, seating of the journal adequate to the load is continuously maintained. Under such conditions, metal bearings wear into conformity except where there is frequent change in the direction of journal pressure, when they never actually become properly seated at all. In either case, the rate of wear is rapid, and chafing and scoring are too frequently present.

The accurate conformation to the journal, combined with inherent grease-retaining qualities and the non-metallic nature of the moulded fabric material, maintains lubrication at loads and speeds where metal bearings gall and score the shaft.

The grease-retaining qualities and accurate conformity maintain a more favorable starting condition, re-

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sulting in a starting coefficient about half that of metal bearings.

The foregoing qualities have been demonstrated time and time again on many kinds of difficult applications such as large jaw crushers, power shovels, hoists, cranes and rubber mills.

It seems that the normal resistance to change inhibits the use of moulded fabric bearings other than where conventional bearings are extremely troublesome. On any number of applications, where short life is accepted as unavoidable with conventional materials, moulded fabric bearings are giving long, trouble-free service. The results generally are so favorable that it is not uncommon for one installation to lead to a complete survey of upkeep costs attributable to various bearing applications throughout the plant.

It is well to make it a point to consider the advantages of moulded bearings for application whenever a bearing replacement is imminent. Of course, moulded fabric bearings were never intended to replace conventional bearings on all applications, but on the applications for which they are recommended, moulded fabric bearings give superior results.

A most interesting experience occurred with a well established manufacturer of heavy equipment who has used our friction materials for years. Several years ago, without our recommendations, they made a test application of our bearings which were incorrectly installed, and the results were far from satisfactory. However, this company later ran into a condition that gave them so much trouble they were willing to try anything. Moulded fabric bearings were selected and installed in accordance with our recommendations.

The results were so favorable that they have extended the use of moulded fabric bearings to a great many applications where conventional bearings had been giving reasonably good results. The advantages obtained were greatly improved service life, elimination of frequent bearing failures, and reduction of wear to journals. In addition to better performance and greatly extended wear life, costly reconditioning and shaft replacement was avoided when bearings were renewed.

Some specific rolling mill applications are feed and delivery rolls, and rolls for tables and conveyors of all types. Neither shock from the manipulation of the heaviest ingot nor discharge from reheat furnaces, nor water splashed from the rolling operation, have any detrimental effect. Here again, water is the preferred lubricant, and it provides protection when hot metal must stand on the rolls for a period of time. Oil or grease is also being used with highly successful results. Incidentally, since our bearings are not critical as to the lubricant, a grade most resistant to heat or other conditions to be encountered can be employed even though unsuccessful with metal.

In one case on a reheating furnace, during the several years our bearings have been serving in the delivery table, it has been necessary to replace but one bearing, and this resulted from a fish obstructing the water pipe. Previously, replacements had been so frequent that no record could be maintained, and they took advantage of every down turn to make needed replacements.

Twist guides, and the very modern precision merchant mill are locations that are best served with moulded fabric bearings.

While it has not become general practice to convert pinion stands to fabric bearings, those who are using them find them to be a big improvement. Water lubrication provides the minimum friction, but oil is frequently used, as in some stands it is difficult to exclude the water from the pinions. When oil lubricated, a flow sufficient to carry off heat incidental to friction is maintained. Even where drip lubrication has been employed in conjunction with water cooled housings, results have far exceeded those obtained from metal.

Cranes and material handling equipment of all types offer practically unlimited opportunity for improved performance and freedom from servicing by the use of fabric bearings. Such economies are well illustrated by a locomotive crane now in uninterrupted service for three years compared with a maximum of six months prior to the installation of fabric bearings. We have recently been advised that the equipment continues to perform in the same satisfactory manner.

Fabric bearings are also used in crawlers for shovels that must operate in slag pits. Unlike metal bearings, they are immune to the acid water that must be encountered.

DISCUSSION

PRESENTED BY

R. A. KRAUS, Lubrication Engineer, Republic Steel Corporation, South Chicago, Illinois

W. A. RANKIN, Engineering Division, Bearings and Gears, Gatke Corporation, Chicago, Illinois

C. E. PRITCHARD, Lubrication Engineer, Republic Steel Corporation, Cleveland, Ohio

R. A. Kraus: It was mentioned in the paper that grease will adhere to composition type bearings in a manner not possible with metal. Inasmuch as my experience does not bear this out, I wonder if Mr. Rankin will elaborate on this.

W. A. Rankin: If you apply oil or grease to both metal and fabric bearings and let them stand, you will see that the grease or oil remains on the fabric for a much longer period than it does on any of the metals. There is less adhesion to metal compared with the adhesion to the fabric. Another important factor is the accurate conformation to the shaft under excessive pressure. This fit not only eliminates voids and effects uniform distribution of all available lubricant, but enables a very thin film to provide effective lubrication. The effectiveness of water lubrication even under the heavy unit loads of roll neck application indicates that a very thin lubricating film suffices.

R. A. Kraus: It was also mentioned that you have applied composition bearings to pinion stands. You recognize the fact that a composition bearing is a good

heat insulator. I would like to inquire about the removal of heat from these bearings as compared to water lubricated composition bearings or conventional babbitt bearings.

W. A. Rankin: Provision must be made for removal of heat. Oil flowing over the shaft and around the bearing acts as a coolant and carries away the heat. Therefore a flow of oil, under conditions that permit the oil to cool, is recommended in preference to grease.

Moulded fabric bearings with slight lubrication by grease or oil, cooled by the flow of water on the outside of the housing are giving service so far ahead of metal that the users would not consider going back to metal. However, with moulded fabric bearings, heat should be removed as directly as possible from the journal. Application of the coolant to the journal is recommended.

R. E. Kraus: What about thermal plugs in such applications?

W. A. Rankin: That would depend on individual applications. The general idea definitely has merit, but is something that has not advanced as far as it should.

C. E. Pritchard: Mr. Rankin commented about a drip tank lubricator being a satisfactory arrangement with composition bearings. I know in the past that I have had some rather disastrous results with the high speed installations so equipped. Can he give us any information on this phase of application?

W. A. Rankin: Our experience has shown the application to be satisfactory in conjunction with water cooled housings. Of course it depends on the load, the speed, and the amount of oil used. As mentioned before, the tendency seems to be to use moulded fabric bearings only on troublesome applications. In extreme cases special attention should be given to many factors, and it is important to remember that moulded fabric bearings are very different from metal bearings. They have qualities not found in metal bearings, but, especially on critical applications, adequate provision for cooling is essential.

C. E. Pritchard: It happened in our case that the shaft turned blue due to the lack of heat dissipation of the composition bearing material, and we had to replace it with a metallic bearing.

W. A. Rankin: It is evident that the circulation of oil was not adequate to remove the heat under the operating conditions. The solution is to increase the flow of oil, or to provide better cooling of the oil.

It is well to remember that the term "composition bearing" is by no means specific. Moulded fabric bearings are made of many different material combinations to provide proper performance characteristics for specific service conditions. Our application recommendations are based on many years of specialized experience. Very likely the bearings you are discussing were not.

C. E. Pritchard: You mentioned that the locomotive crane was equipped with composition bearings and successful operation was received henceforth. I was wondering if there was anything other than the composition bearings themselves that could contribute to the success indicated, or was it in your opinion the only thing that made the difference in the results obtained between the metal and the composition?

W. A. Rankin: You cannot put a moulded fabric bearing on a badly damaged journal and expect it to give satisfactory performance. As far as we know, the crane that we are using as an example was properly maintained previously and when the bearings were installed, journals were put in good condition. We are constantly demonstrating superiority under such conditions, particularly where there is shock, vibration, and other irregularities which cause bearings to suffer.

C. E. Pritchard: From that, I would draw the conclusion that the answer was the difference in the material compared to the metal used previously?

W. A. Rankin: Yes.

Member: We happen to have an installation of that particular type and I happen to know there was a single lubricating system installed at the same time as the composition bearing and I, for one, would attribute a good 50 per cent of that success, if not more, to that.

W. A. Rankin: Regarding the cases under discussion there was not change in the lubrication system. Our moulded fabric bearings are being used by several manufacturers for similar services with exactly the same lubricating facilities as provided for metal bearings.

On applications such as we have in mind, it would be a mistake to expect anything like comparable results through improved lubrication of metal bearings. There are any number of cases, some including pressure lubricating systems, where the lubrication was beyond question and where moulded fabric bearings have eliminated chafing, scoring and rapid wear which consistently occurred with metal bearings. We do not mean to infer that there are no applications where improved lubrication would not materially improve metal bearing performance, but it definitely is not the answer in the cases we are discussing. Nor do we intend to imply that moulded fabric bearings are either cure-alls or beyond misuse of misapplication. In fact, the reverse is true. Moulded fabric bearings are not recommended for some applications, but on the numerous applications for which they are recommended, results are superior.

Mark Your Calendar.....

May 26 and 27, 1947

AISE ANNUAL SPRING CONFERENCE

BENJAMIN FRANKLIN HOTEL, PHILADELPHIA, PENNSYLVANIA

FLAME CONDITIONING AND CUTTING OF STAINLESS STEELS

. . . . extract of a paper entitled, "Powder-Cutting and Scarfing of Oxidation-Resistant Materials," presented by D. H. Fleming of the Linde Air Products Company, at the 1946 annual meeting of the American Welding Society . . . .

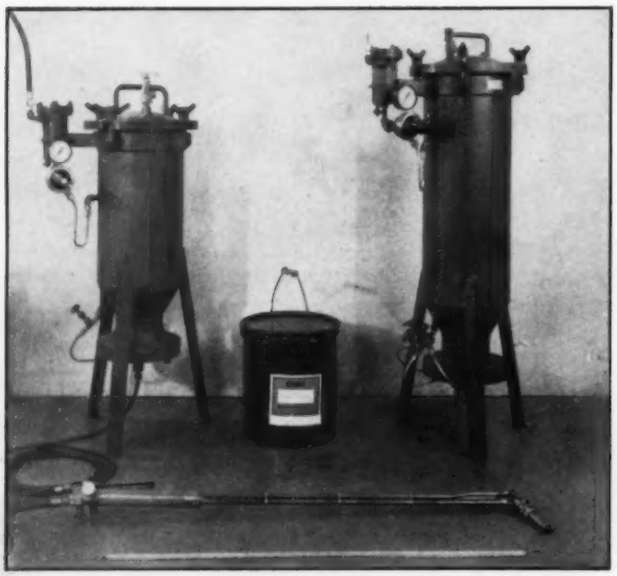


Figure 1 — Single and triple outlet dispensers used in the powder process together with a 100 lb drum of powder and 44 in. hand-scarfing blowpipe.

▲IN the past the oxyacetylene cutting methods have not been as applicable to the fabrication of stainless steels as they have been to carbon steels. The alloying elements, chromium and nickel, which impart the desirable properties to stainless steels, have made these steels difficult or impossible to process by normal oxyacetylene cutting. Of the two, the chromium represents the greatest problem, for when any oxyacetylene cutting is applied to stainless steels, the chromium, which has a high affinity for oxygen at elevated temperatures, immediately forms the highly refractory chromium oxide on the faces of the kerf and prevents further oxidation. The nickel does not appear to present so much of a problem inasmuch as a refractory oxide of this material is not formed.

A number of means have been used in the past to get around the refractory effect of chromium oxide. The most commonly used process involves the use of an oscillatory motion of an ordinary hand-cutting blowpipe. An extremely heavy preheat and oversized nozzles are used. The overall economy of the process is not very good, for the cutting is quite ragged and the speeds are slow. The powder method is one way of cutting stainless steels more effectively. Using the same size nozzle and operating conditions, the time required by the oscillation method was three and a half times that required by the powder-cutting method.

Because of the limitations of the old severing methods, mechanical means have been used almost exclusively for the conditioning and cutting of stainless materials until the advent of the powder-scarfing and cutting process.

THE POWDER-SCARFING PROCESS

To provide the continuous progressive application of the cutting or scarfing process to these materials and provide a high quality cut surface, it was necessary to devise some means for either melting or fluxing out the chromium oxide that was formed. Years of research and development have been involved in the study of materials to give the desired chemical action. The net result of this development was the selection of finely divided iron-rich powder as the additive material.

In cutting operations this powder is usually blown into the oxygen stream from outside of the nozzle preheat flame, while in scarfing, the powder is drawn into the oxygen stream within the nozzle.

In both cases, the powder is heated to the ignition temperature by the oxyacetylene preheat flame similar in gas flow to carbon-steel preheat requirements, at which time it burns in the oxygen stream to create an extremely high-temperature reaction. The extreme heat of this reaction makes it possible to start cutting or scarfing without pausing for any preheat period. As soon as the cut progresses into the material, the refractory oxides are continuously removed by a combination melting and fluxing action. The powder that is used and the resulting products of combustion that are present in a heavy smoke cloud are both non-toxic.

Figure 2 — This photograph of the as-poured condition of the ingot shows the porous surface.

OPERATING REQUIREMENTS AND SPEEDS

The use of iron-rich powder permits both scarfing and cutting operations. Hand-scarfing operations on stainless steel are carried out at a speed approximately one fourth to one third the speed used on carbon steel, with equivalent oxygen flows and the added factor of powder. The cutting of all types of stainless steel can be accomplished at cutting speeds comparable to equivalent thicknesses of carbon steel, but it is generally necessary to use a nozzle one size larger than that which would be used on carbon steel of the same thickness. Powder-flow requirements for cutting vary from ¼ to ½ lb per minute, depending upon the thickness of the material.

The apparatus required for powder-cutting or scarfing is relatively simple and inexpensive. A common piece of apparatus that is required by both cutting and scarfing is the powder dispenser. This is essentially a pressure vessel with a powder ejector built into the bottom flange. It operates entirely on a small flow of compressed air through the dispenser, the powder being picked up by the air flow through the ejector and carried through ordinary rubber hose to the blowpipe. The dispenser holds sufficient powder for at least 8 hours continuous operation. For hand-scarfing, a special 44-in. long powder blowpipe is used. In addition to the usual two-hose oxyacetylene hookup, a third hose carrying the powder is led to the blowpipe from the powder dispenser. Single and triple outlet dispensers together with a 44-in. scarfing blowpipe and a 100-lb drum of powder are shown in Figure 1. The powder passages are an integral part of the blowpipe construction. The same general design is used for the hand-cutting blowpipe, which is 28 inches long. Special powder-scarfing and powder-cutting nozzles are used in conjunction with these hand-operated blowpipes. The valve lever that ordinarily actuates the cutting oxygen is also used to turn on the powder on these particular blowpipes. The valves are so arranged that the powder comes on slightly before the cutting oxygen, to further insure a flying start.

Figure 3 — Powder-scarfing stainless ingot.

TYPICAL SCARFING APPLICATIONS

In the steel mill, the process finds its principal application in the conditioning of stainless steel and in cutting of sections generally ranging from 3 to 24 or 26 inches. Large bloomed ingots, small unrolled ingots, slabs, and billets are generally the type of work handled by powder-scarfing. In the case of the bloomed ingots, these are generally covered with severe cracks and corner tears that in some cases are as deep as 2 or 3 inches. It is an extremely laborious job to remove all the cracks by grinding; however, by powder-scarfing, it is possible to condition an ingot of 12,000 lb in a matter of 4 to 6 hours, as contrasted with a possible 48 hours or more that would be required for grinding. The small unrolled ingots generally do not have any cracks, but have a spongy surface approximately 3/16 in. deep, as shown in Figure 2. The spongy surface must be removed before a quality product can be rolled.

TABLE I

Powder-Cutting Data
Clean 18-8 Stainless Steel

Thickness, in.	Nozzle size	Cutting oxygen, psi	Powder consumption, lb per hr	Cutting speed, in. per min
¼	4	50	15	24
½	6	50	18	20
1	6	50	18	15
2	8	50	18	11
4	10	50	18	7
6	12	50	22	5
8	14	65	24	4
10	16	65	24	4
12	20	75	30	4
14	20	75	45	3
16	24	75	45	3
18	24	75	45	2
20	24	75	45	2

Figure 4 — The apparent ridges in the ingot surface after scarfing are imperceptible in the rolled product.

This can be accomplished by completely removing the defective surface. It is possible to condition a heat of 22 to 24—1000 lb ingots in one eight-hour turn by this method with two powder-scarfing blowpipes. An ingot in the process of being scarfed is shown in Figure 3. Figure 4 shows the same ingot after the scarfing has been completed.

In the scarfing of heavy slabs and billets, the same conditions apply as in the scarfing of the small ingots or the bloomed ingots. In many cases, however, material of this type, so badly cracked that it would be economically unfeasible to condition it by grinding, can easily and quickly be reclaimed by the use of powder-scarfing because of the great speed that can be obtained. On stainless slabs and smaller cross-sectioned billets, about 3 to 4 in. thick, the depth of the defects is such that grinding and scarfing are approximately equivalent on a cost basis. A higher quality job can be obtained by powder-scarfing, for it is not possible to cover up defects in the material. On the other hand, in grinding an operator can smear over small cracks by leaning heavily on the wheel.

The cutting process in the steel mill has found valuable use in the removal of hot tops from large ingots or bloomed ingots. The cutting speed on heavy sections from 14 to 26 in. thick, averages approximately 2 in. per minute, the only variation being in the oxygen-flow requirements. It has been possible to remove the hot top from ingots 18 in. thick and 56 in. wide in 28 minutes, with a high quality edge being produced. For this class of work, nozzles providing 2000 to 2500 cu ft of oxygen per hr are required, and an average of 30 to 40 lb per hr of powder is used. In spite of the heavy section, flying starts are obtained on this material. Prior to the inception of the powder-cutting process, these ingots were cut by the oscillation method, which required at least two hours to remove the hot top of the type mentioned. With the oscillation method, in many cases it was not possible to penetrate completely through in one pass, and it was therefore necessary to turn the ingot over and cut from the opposite side in order to complete the cut.

Slabs that are rolled from ingots often have very badly cracked edges, although the flat surfaces are in reasonably good condition. Before any re-rolling can be accomplished on these pieces, it is necessary to remove the cracks completely. In many cases the crack condition is such that the piece can be considered little more than scrap, but with the use of the powder-cutting process, it is possible to trim off the scrap edge and then subsequently cut the slab to size for rolling into final finished-plate size. The use of the powder-cutting process for removing cracked edges of slabs has resulted in a savings of thousands of dollars per week, merely by making it easier to reclaim slabs that would otherwise be considered absolute scrap. Some of this work had previously been accomplished by the use of carbon arc, but the speeds in this case were a third to a quarter of those obtained with the powder process.

A further use of the process in stainless steel production is the cutting to size of relatively thin plate about 1 to 2 in. thick, to be made into carbon and stainless steel sandwiches, prior to rolling into clad plate. Plate can be cut to actual customers' specification size, which is something not previously done generally in steel mills because of the difficulty in actually cutting the material.

AISE TESTS HOT METAL LADLE

Shown here is a model of a hot metal ladle which is now under test at the Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pennsylvania. This model is one of several being used in an extensive research program sponsored by the Association of Iron and Steel Engineers. The object of the work is to analyze the stresses in hot metal ladles, so that rational design formulae may be established. A better knowledge of the stresses will enable designing the ladles to save weight and maintain present strengths. Two of the models which are being tested are of welded design and one is of riveted design. The dimensions of the model are about 1/5 those of full size ladles, and have a capacity of about 1½ tons. The model dimensions are based on a 150 ton ladle. The models are being tested with mercury loads as well as water and heavy liquids. One test may be made with hot metal. Stresses in the model are being measured by means of dials and by electric strain gauges similar to those used in testing airplanes. The work is being done by Professor B. J. Johnston and W. H. Munse of Lehigh University, and the AISE committee guiding the work is headed by F. E. Kling of Youngstown, Ohio.

TENSION SIZING OF SMALL DIAMETER SEAMLESS PIPE AND TUBING

. . . . this paper was prepared from data obtained by the Stretch Reducing Mill Committee of National Tube Company, United States Steel Corporation Subsidiary, Pittsburgh, Pennsylvania. This committee was composed of S. W. Stouffer, chairman, J. W. Baxter, G. A. Butler, C. E. Hess, J. Hereford, H. K. Hybarger, G. J. Kirchner, G. A. McGrann, F. M. Scharff, F. Schaeffer, and W. Wehmen . . . .

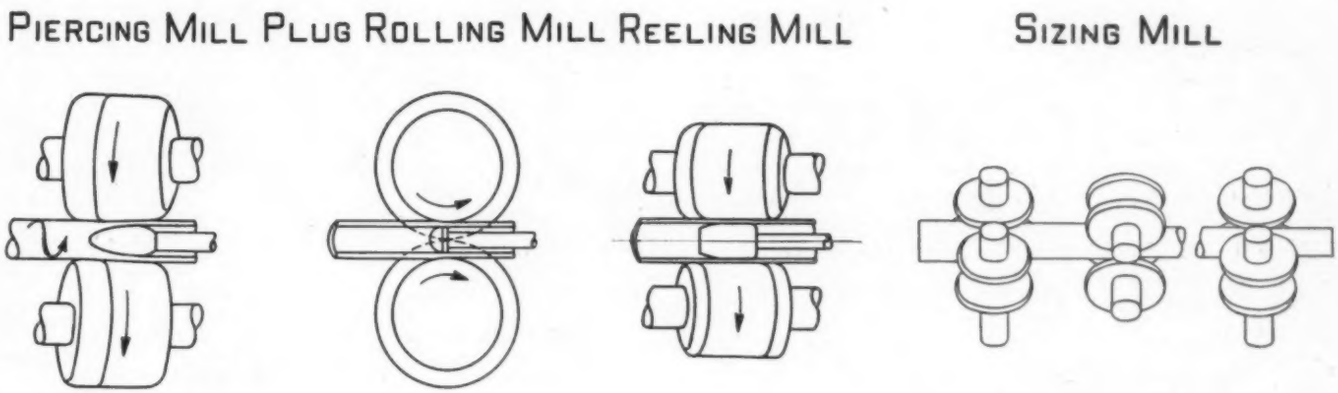


Figure 1 — Several methods used in piercing and rolling of seamless pipe are shown in this sketch.

▲ IN the steel industry, it is a matter of general knowledge that the manufacture of small diameter pipe and tubing has been greatly improved during the past few years by the introduction and development of the Fretz-Moon continuous butt weld and the continuous electric weld processes. However, it is not generally known that improved rolling processes of comparable importance have been developed by the seamless industry, the use of which will permit the manufacture of small diameter, hot rolled, seamless pipe and tubing at greatly improved production rates. One of the more important developments contributing to the improvement in productive capacity of seamless tube mills is the use of tension in the final sizing operation on the hot mill. The application of this principle not only permits substantial reductions in wall thickness of the tube to be made in the sizing mill, but also provides a means for making exceptionally large reductions in the diameter of the tube with a relatively small number of roll stands. These features overcome one of the principal obstacles to the rolling of small diameter seamless pipe, namely, the inability to make large diameter reductions in the sizing mill without adversely affecting the quality of the product, a requirement

Presented before AISE Annual Convention, Cleveland, Ohio, October 4, 1946, by Stevenson Findlater, assistant to president, National Tube Company

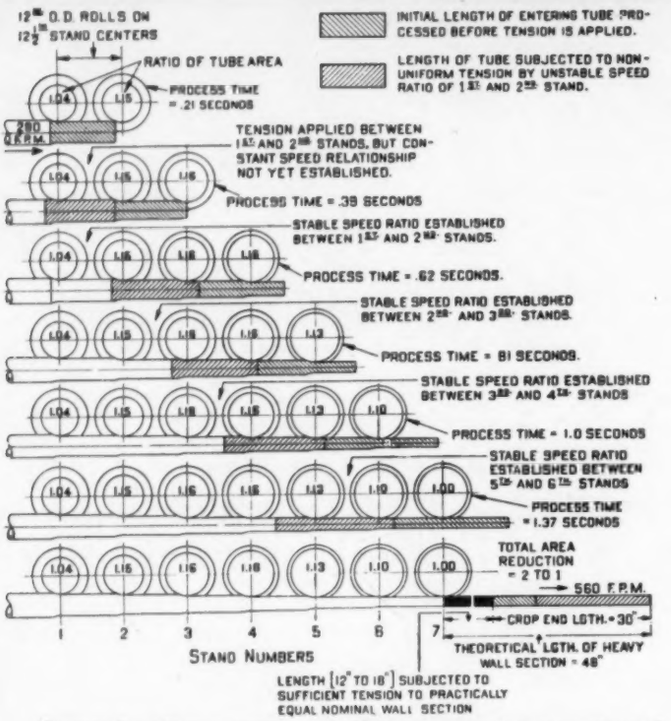

12" O.D. ROLLS ON 12½" STAND CENTERS
INITIAL LENGTH OF ENTERING TUBE PROCESSED BEFORE TENSION IS APPLIED.
LENGTH OF TUBE SUBJECTED TO NON-UNIFORM TENSION BY UNSTABLE SPEED RATIO OF 1ST AND 2ND STAND.
RATIO OF TUBE AREA
PROCESS TIME = .21 SECONDS
200 R.P.M.
TENSION APPLIED BETWEEN 1ST AND 2ND STANDS, BUT CONSTANT SPEED RELATIONSHIP NOT YET ESTABLISHED.
PROCESS TIME = .39 SECONDS
STABLE SPEED RATIO ESTABLISHED BETWEEN 1ST AND 2ND STANDS.
PROCESS TIME = .62 SECONDS.
STABLE SPEED RATIO ESTABLISHED BETWEEN 2ND AND 3RD STANDS.
PROCESS TIME = 81 SECONDS.
STABLE SPEED RATIO ESTABLISHED BETWEEN 3RD AND 4TH STANDS
PROCESS TIME = 1.0 SECONDS
STABLE SPEED RATIO ESTABLISHED BETWEEN 5TH AND 6TH STANDS
PROCESS TIME = 1.37 SECONDS
TOTAL AREA REDUCTION = 2 TO 1
560 F.P.M.
CROP END LGTH. = 30"
THEORETICAL LGTH. OF HEAVY WALL SECTION = 48"
1 2 3 4 5 6 7
STAND NUMBERS
LENGTH [12" TO 18"] SUBJECTED TO SUFFICIENT TENSION TO PRACTICALLY EQUAL NOMINAL WALL SECTION

Figure 2 — The progress of a tube through 7 stands of a 16-stand, stretch reducing mill is shown in this chart. A heavy wall section is shown developing at the front end of the tube. Process sequences are based on time required for motor speed of the consecutive stands to attain stable speed relationships as shown by graphs of motor loads and speeds in Figure 11.

which is dictated by the practical limitations of the preceding piercing and rolling operations.

In the seamless piercing process, a solid round billet is helically rolled between two barrel or cone-shaped rolls, the action of which forces the billet over a mandrel, or point, positioned between the rolls in such a manner that a hole is introduced in the center of the billet, as shown in Figure 1. The heavy thrust and frictional load applied to the piercing point in such an operation limits the length of billet which can be pierced without destroying the point, and this condition, together with the relatively slow rate of piercing, encourages the use of the largest possible billet diameter consistent with the size of finished product to be rolled.

A similar condition prevails in the subsequent rolling operation which is designed to reduce the wall and elongate the pierced billet, and in the reeling operation which is designed to improve surface quality and contour of the section. In seamless mills of conventional design, these operations are done in two types of mills. The first is a single-stand two-high rolling mill, in which the pierced shell is given two or more passes over a stationary plug; the second is a reeling machine, in which the tube is cross rolled between two cylindrical shaped rolls and over a rotating plug. Similar rolling operations are also done in a slightly different manner in the Diescher mill, in which the pierced billet is helically rolled on a floating mandrel between two barrel-shaped rolls; and the continuous rolling mill, in which the pierced billet is consecutively reduced in a series of two-high roll stands on a floating mandrel. Since all of these processes, in common with the piercing operation, use a plug or mandrel, they are similarly restricted as to minimum diameter and length of product which can be efficiently rolled. Accordingly, for optimum productivity the manufacture of small pipe sizes, under 3 in. outside diameter, is preferably done by piercing and rolling relatively large diameter billets and subsequently reducing and sizing the shell thus produced to the desired finished dimensions in a reducing or "sinking" sizing mill, as it is commonly termed.

In general, sinking-sizing mills consist of several two-high roll stands located in tandem, with alternate stands inclined in opposite directions at an angle of 45 degrees with the vertical center line of the mill. Since the tube does not rotate while being processed, the alternate stand settings provide a means for uniformly working all portions of the tube. In the operation of these mills, no plug or mandrel is used to support the inside of the tube, and in standard sinking mill practice, where little or no tension is introduced between the roll stands, the amount of reductions which can be taken without adversely affecting product quality is about 3 per cent of the average diameter of the tube section entering the stand. With such a limitation, the heavy overall diameter reductions involved in the production of small pipe sizes require a large number of passes, and in actual installations the number of stands per mill may range from twelve to as many as twenty-four, depending on the finished size to be produced.

Roll pass schedules for the sinking-sizing operation are designed to distribute the reduction more or less uniformly among all stands, excepting the last two which are used to round up and size the tube to finished dimensions. Roll speeds are calculated to maintain a constant volume rate in each pass and ratios between consecutive roll stands are generally established so that, theoretically, each set of rolls acts as an independent unit relative to its action on the tube in process. Although technically, transmission of forces from one stand to another is eliminated by this procedure, the roll speed ratios are often increased slightly in order to insure against any longitudinal compression of the tube between stands.

DISADVANTAGES OF THE CONVENTIONAL SINKING-SIZING PROCESS

While the operating principles outlined above have been used for many years to produce seamless pipe in the smaller size ranges, there are certain characteristics of this method of sizing which render it unsuitable for the manufacture of light wall product, as well as for finished tube sizes which require relatively large diameter reduction of the reeled shell to obtain economical production rates. One such feature is the increase in wall thickness produced by the sinking operation. Since the reduction of the tube in the pass subjects the section to compressive forces, and as there is no internal restriction to radial flow of the metal, only a portion of the displaced metal goes into elongation while the balance tends to heavy up the wall of the tube. For this reason, the wall thickness of the shell entering the sinking mill must be rolled from 0.010 to 0.030 in. lighter than the desired wall of the finished tube, which feature becomes a distinct handicap in the rolling of light wall product,

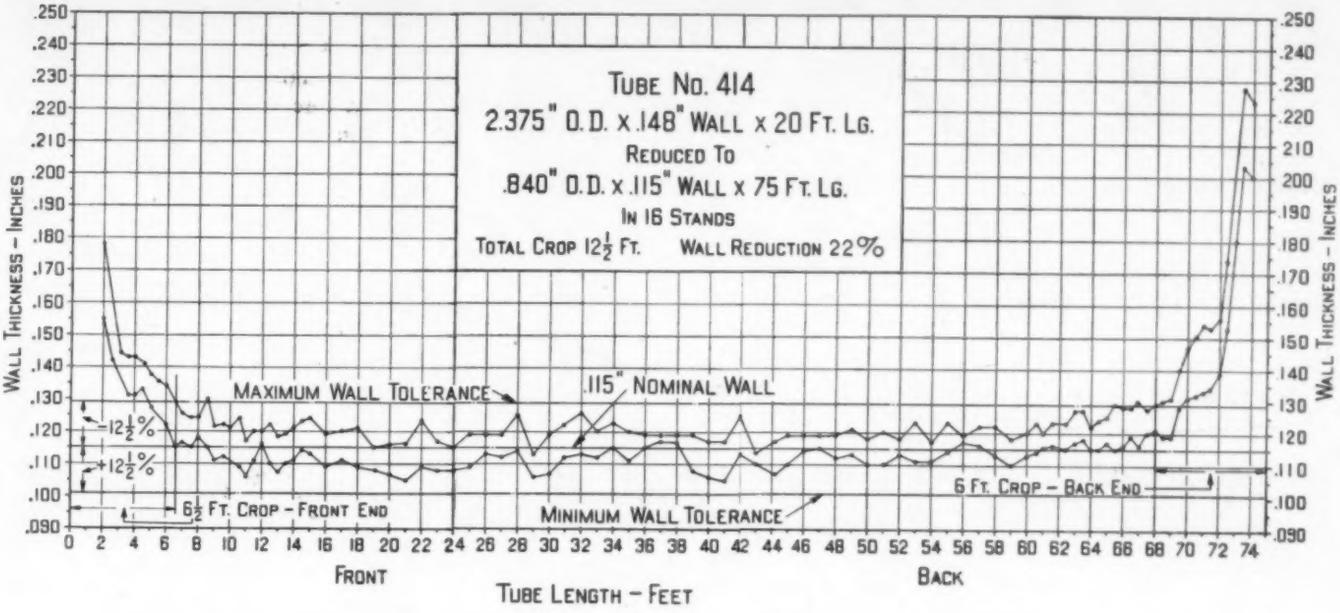


Figure 3 — The graph of maximum and minimum wall readings taken at intervals along the length of the stretch-reduced tube shows the crop loss entailed because of the end thickening.

since the piercing and rolling operations become progressively more difficult as the wall thickness is decreased.

A further handicap to conventional sinking mill practice is the limited amount of overall diameter reduction which can be made without seriously effecting the quality of the product. Experience has indicated that the maximum number of roll stands which can be operated efficiently on a high production mill is about sixteen. The cumulative wall increase developed in this number of passes in combination with the working of the tube section on alternate axes tends to produce an irregular inside contour which becomes more exaggerated as the number of passes is increased, despite the fact that relatively small reductions are taken in each stand. It is also more difficult to keep each pair of rolls properly adjusted when a large number of stands are in service, and the chances of producing tubes with external ridges and offsets are much greater under such circumstances. By limiting the number of stands to sixteen or less and avoiding the use of diameter reductions per stand in excess of 3 per cent, these adverse conditions can be held to a point where product quality is not noticeably affected. However, the imposition of such limitations on both diameter reduction per stand and the number of stands automatically restricts the maximum overall reduction which can be made in the sinking mill to between 35 and 40 per cent of the original tube diameter. This restriction not only holds down the production rates which can be achieved on sizes under 2 in. outside diameter due to the limited size of reeled shells which can be used, but also renders the rolling of tubes under 1½ in. outside diameter impractical due to the extremely small diameter shells required, most of which are below the minimum size that can be pierced and rolled over a plug.

SIZING MILL OPERATION IMPROVED BY USE OF TENSION

The disadvantages of the sinking-sizing process have been recognized for many years, and considerable time and effort have been devoted to the development of methods for overcoming the objectionable features of the operation. The most promising development to date is the application of tension to the tube between consecutive roll stands of the sizing mill. In principle, the operation involves the introduction of tension in the tube section by increasing the relative speeds of the rolls in successive stands to a greater degree than required to compensate for the change in section area produced by the reduction in the several roll passes. The tension or pull thus applied to the tube as it passes between consecutive stands produces a slight reduction in area of the section by stretching. Since the piece is in tension, the resultant metal displacement goes into elongation and a reduction in the wall of the tube is thus effected. With the application of sufficient tension, the reductions in wall developed between stands can be made to exceed the amount of thickening produced by the compressive forces developed in the roll pass, thus permitting the production of finished tubes of lighter wall than the entering shell. Through the elimination of the cumulative build-up of the wall and the attendant tendency to produce irregular inside contour, the application of tension to the tube also makes possible the use of relatively large diameter reductions per stand, thereby permitting equivalent overall reductions to be made in fewer stands in comparison with the sinking process. However, while overcoming the principal disadvantages of the sinking-sizing operation, the reduction by tension, or "stretch-reducing," as it has been termed, introduces an objectionable feature, namely, the end-thickening of the wall of the reduced

tube caused by non-uniform application of tension to the tube as it enters and leaves the several stands of the sizing mill. The problem of controlling the amount of end-thickening along with the achievement of the desired diameter and wall reduction in the stretch-reducing operation serves to make it a complicated procedure requiring specially designed equipment and carefully planned operating schedules.

DESIGN FEATURES OF THE STRETCH-REDUCING MILL

The design of the stretch-reducing mill is primarily complicated by the necessity for maintaining the center distance between consecutive roll stands as small as possible. Since tension is developed between the roll stands, no tension can be applied until at least two sets of rolls are working on the tube, and the entering portion of a tube being processed is not subjected to tension until the end of the tube is in the second stand of the mill, as shown in Figure 2. Consequently, a portion of the entering end of the tube, roughly equal to the center distance between the first and second stands, is initially subjected to compressive forces only, with the result that the wall thickness of this section is increased before tension is applied. Subsequent increments of the tube are subjected to tension immediately upon entering the first stand, the effect of which is to reduce the upsetting action of the rolls, as well as stretch the tube between the stands, thereby producing a section having lighter wall than the portion already processed. This sequence is repeated as the front end of the tube progresses through additional stands, the wall of the extreme front end becoming heavier with each successive reduction. However, since elongation is also taking place between each roll pass, only a part of the entering heavy wall section is reduced before contact is made with the succeeding stand, and the balance of the original heavy end is therefore subjected to uniformly increasing amounts of tension as it is reduced and elongated in successive passes. Since the extreme front end of the finished tube is subjected to little or no tension, it will have a relatively heavy wall. Subsequent lengths, having been subjected to varying amounts of tension, will have walls of gradually decreasing thicknesses tapering back to a point where the full amount of tension developed by each stand in the entire mill has acted on the tube and thus established a constant nominal wall thickness. The same condition will apply as the tube leaves the mill, so that all tubes which have been stretch-reduced will have a heavy wall section on the front and back ends, shown in Figure 3. Since the length of the heavy end section is determined to a large extent by the center distance between the roll stands, stand spacing must be kept to a minimum in order to avoid excessive cropping of the finished tube due to off-gage ends.

In view of the difficulties involved in constructing and operating a mill of conventional design with

Figure 4 — This view of a 16-stand reducing sizing mill shows the close stand spacing required.

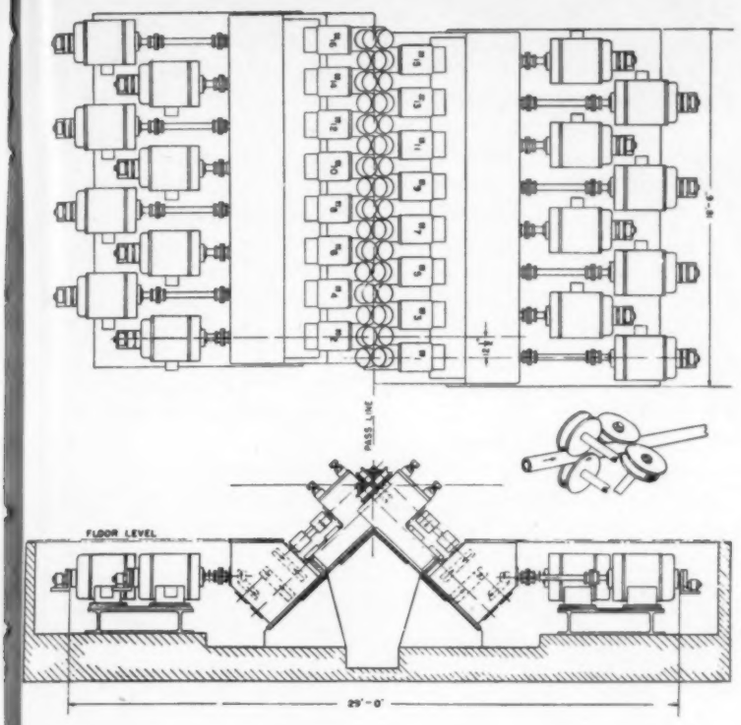


Figure 5 — General arrangement of the 16-stand mill shown in Figure 4.

extremely close stand spacing, the designers of stretch-reducing mills have resorted to the use of overhung roll mountings. Since the rolls can be changed on this type of mill without disturbing the bearings, fixed housings can be used, thus providing necessary strength and rigidity, while allowing the machinery to be crowded into a relatively small space. A typical example of this type of construction is a sixteen-stand sizing mill recently installed in connection with the modernization of an existing seamless tube mill. See Figures 4 and 5. In common with most multi-stand sizing mills, alternate stands of this mill are located at right angles to each other, and all stands are inclined 45 degrees to the vertical center line of the mill. The eight stands on each side of the mill are securely mounted to a common bedplate, and in addition, are interconnected by spacers inserted between the bearing housings. The rolls used on this mill are 12 in. in diameter, yet the center to center distance of consecutive roll stands is only 12½ in., making the entire length of the mill slightly less than 20 feet.

In order to operate the stretch-reducing mill effectively on schedules involving a wide range of product sizes, considerable flexibility is required in the selection of roll speeds. Different speed ratios between consecutive stands are required not only for each condition of diameter and wall reduction, but also for incremental adjustments in roll speeds which must be made to compensate for frictional losses, slippage, and similar indeterminate factors encountered in the reducing process. The simplest and most effective means of meeting this requirement is the use of individual motor drives for each of the stands. By means of variable voltage control, the delivery speed of the mill can be adjusted without affecting the relative speeds of the individual stands, yet any of the stand speed relationships can be varied with respect to each other by field adjustment of the individual motors. In the mill described above, each roll stand is driven by a 75 hp, 850/1750 rpm, 230 v, d-c, motor, power for which is supplied by a 1500 kw motor-generator set equipped with adjustable voltage control. The control for each drive motor includes both a motor operated coarse, and hand operated vernier field rheostat for accurate speed adjustment. Reduction gears in each of the stand drives are of such ratios that various combinations of motor speeds will provide roll speed ratios between the first and last stands as high as 1 to 4 and as low as 1 to 1, as well as any ratio between these limits. The wide range of speed ratios permits the mill to be used either as a conventional sinking mill, or as a stretch-reducing mill, and the unit is frequently referred to as a "universal" reducing mill on this account. Delivery speeds of the mill range from 300 to 600 fpm, depending on the amount of reduction given the tube.

CHARACTERISTICS OF THE PROCESS DEVELOPED BY PERFORMANCE TESTS

In addition to the provision of a properly designed rolling mill, a thorough appreciation of the characteristics and limitations of the process is required to successfully apply it to the commercial production of seamless pipe and tubing. Basically, optimum operating conditions are obtained when an economic balance is maintained between tonnage output of the mill and overall yield of good product. In order to achieve this condition, the effect of the various factors which determine end-thickening of the wall of the reduced tube must be capable of evaluation within a reasonable degree of accuracy. Similarly, the conditions which determine and limit the amount of diameter and wall reduction possible for a specific rolling schedule must also be known. While many of the factors are readily apparent from a study of the process, the degree and manner in which they affect the operation of the mill are difficult to evaluate by a purely analytical approach. The inter-relationship of many of the factors tends to confuse any such analysis, and actual performance may vary widely from the theoretical results determined for a certain set of rolling conditions. In recognition of this situation, a comprehensive development program was inaugurated over a year ago by National Tube Company to establish the exact nature and importance of the various items which characterize the stretch-reducing process. A series of controlled rollings were conducted on the 16-stand mill described above and a smaller 8-stand sizing mill, which was installed several years ago in an existing butt weld pipe mill to facilitate the production of small diameter standard pipe. In the course of these rollings, approximately 450 tubes of various diameters and walls were processed under a wide range of rolling conditions. Each tube was subsequently sectioned at 6 or 12 in. intervals throughout the entire length of the piece and micrometer readings of the wall were taken at each section. Graphs of the wall readings were then plotted, from which the average wall reductions and lengths of heavy end sections were obtained

for each rolling condition. Power and motor speed data were determined from readings transcribed from a moving picture film of a meter panel-board showing loads and speeds of each of the motors during the time the tube was being processed. See Figures 6 and 7. By plotting the readings of consecutive frames of the film, a series of curves were obtained which indicated the actual loading of each mill and the relative speed of the rolls and the tubing during the rolling operation, as shown in Figure 8. Analysis of the results obtained by these methods has provided interesting and informative data pertaining to the application and limitations of the stretch-reducing process, and the following discussion is principally predicated upon these data.

FACTORS WHICH DETERMINE WALL REDUCTION

The novel feature of the stretch-reducing process is the ability to reduce the wall of the hot-rolled tube while simultaneously reducing its diameter. The amount of wall reduction which can be produced by this method is principally controlled by the factors which determine the tension or pull applied to the tube, as well as the ability of the tube to withstand the effects of such factors without damage. The more important items included in this category are:

1. *Diameter of rolls.* The amount of tension which can be applied by the rolls is directly proportional to the length of contact between the roll and the tube. For a given diameter reduction, a larger roll will provide a greater length of contact, thereby permitting more tension to be introduced in the tube than would be possible with small rolls. Unfortunately, maximum roll size is limited by the necessity for maintaining minimum stand spacings in order to reduce the amount of end-thickening of the tube, which condition precludes the the use of larger roll diameters than are actually required to handle the product range of the mill.

2. *Diameter reduction per roll stand.* Length of contact between the roll and the tube is also determined by the amount of reduction given the tube in each stand, so that increased tension can be secured with the use of heavier diameter reductions, as illustrated in Figure 9. For satisfactory operation of the stretch-reducing mill, diameter reductions per stand must be maintained considerably higher than those used in conventional sinking-sizing mills in order to obtain sufficient tension to actually reduce the wall of the tube. Reductions of 7 to 8 per cent per stand are required on a mill equipped with 12 in. diameter rolls to achieve any substantial reduction of wall, and higher reductions are desirable from the standpoint of developing greater tension between the stands.

3. *Initial diameter of the tube.* With rolls of the same outside diameter, the length of contact between the roll and the tube is proportionately less for large diameter tubes than for small diameter tubes where equivalent reductions, expressed in per cent of entering diameter, are involved. At the same time, the area ratios vary as the square of the diameters, so that the amount of tension or pull per square inch of cross sectional area of a smaller tube is considerably greater than that applied to a larger tube, other conditions being equal. Actually, sufficient tension can be developed in the rolling of small diameter tubes, i.e., tubes under 1¼ in. outside diameter, to pull them apart in the mill. This feature limits the maximum wall reduction on tubes in this size range to between 20 and 35 per cent, depending on the initial wall thickness. On the other hand, it is rarely possible to develop sufficient tension to pull the larger diameter tubes apart, and the amount of wall reduction which can be obtained on such product is determined by the tension which can be developed before roll slippage nullifies the effect of further increases in the speed ratios of the rolls. For practical purposes, the maximum wall reduction which can be produced on larger diameter tubes appears to be about 20 per cent for standard walls, and up to 30 per cent for heavier sections.

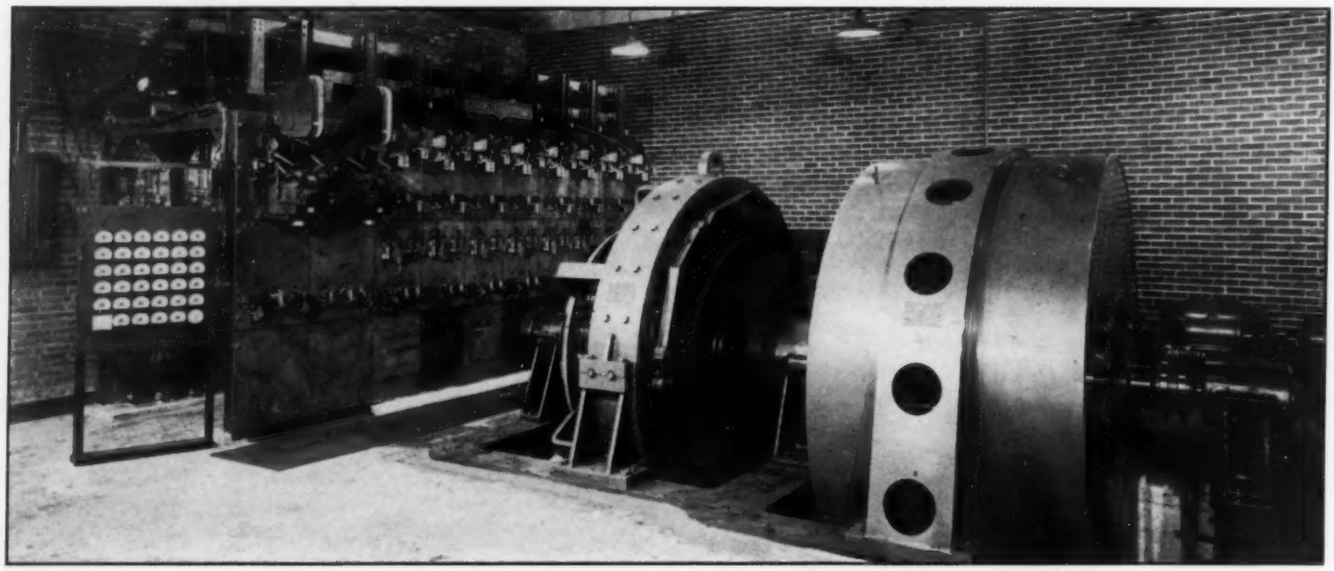


Figure 6 — This control room contains the motor generator set and control for the 16-stand mill shown in Figure 4. On a special panelboard is an ammeter and voltmeter for each of the 16 stands and the motor generator set.

4. *Initial wall thickness of the tube.* In general, tubes with walls ranging from 0.120 to 0.250 in. can be processed with less difficulty than those having either lighter or heavier walls. Variations in the amount of tension applied, as well as variations in cross sectional area of the tube, are less critical in this range than in the case of lighter wall sections, wherein precise control must be maintained to produce the tension required for reduction of the wall without exceeding the ultimate strength of the tube section. Extremely heavy wall tubes are not particularly suited for stretch-reducing, as the excessive upsetting which takes place in the roll passes tends to produce square inside contour, as shown in Figure 10, despite the fact that sufficient tension may be applied between passes to substantially reduce the average wall of the entering section.

5. *Overall diameter reduction of the tube.* In the stretch-reducing process, the total wall reduction obtained is the sum of the incremental reductions produced between each of the several roll stands. Consequently, a greater overall reduction in wall is possible when a large number of stands are in use than when only a few stands are involved. Since the number of roll stands required for a specific mill schedule is principally determined by the overall reduction in diameter of the tube, it follows that a substantial reduction in diameter will permit relatively heavy wall reductions to be made, while with small diameter reductions the maximum wall reduction will be proportionately reduced. In fact, little or no wall reduction can be obtained with much less than 6 stands on small diameter product, under 2 in. outside diameter, or 8 stands on larger sizes, due to the small number of tension increments acting on the tube. For this reason, the process is applicable only to schedules involving overall diameter reductions above 30 to 35 per cent.

6. *Roll speed ratios.* The amount of wall reduction produced under a specific set of mill conditions can be varied within the limits determined by the factors cited above, by changing the relative speed ratios of consecutive roll stands. In this manner finished tubes of several wall thicknesses can be produced from the same entering shell size with no change in the mill setting aside from adjustment of the several motor rheostats.

FACTORS AFFECTING END-THICKENING OF THE WALL OF THE REDUCED TUBE

Of equal importance to the successful application of the stretch-reducing process is a knowledge of the factors which determine and control end-thickening of the wall of the reduced tube. Maximum yield will be obtained only in cases where all of the factors are recognized and properly evaluated in establishing rolling schedules which will produce a minimum amount of crop end loss for a given reduction. As outlined in an earlier part of this article, end-thickening is caused by non-uniform application of tension to the entering and leaving portions of the tube, and theoretically, the portion of the entering tube processed after the front end enters the second stand and before the back end leaves the first stand will have uniform wall by virtue of having been subjected to the full amount of tension

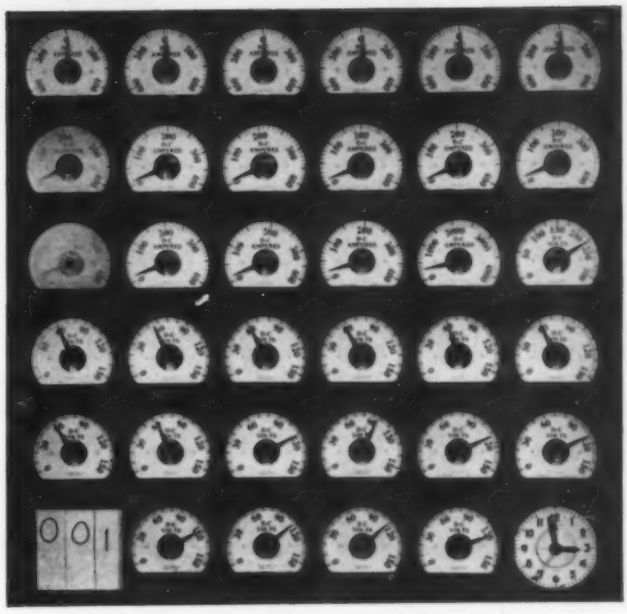
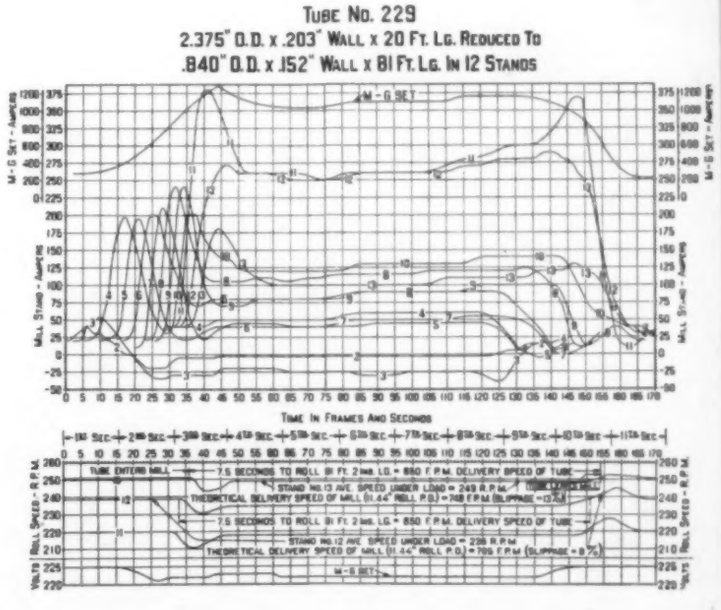


Figure 7 — Moving picture photography of the special meter panelboard provided data for study of motor performance during mill operation.

developed by each roll stand in the entire mill. In actual practice, however, uniform wall is not produced on the entering end until a stable speed relationship is established between the first and second stands. Some time is required for the first stand to become adjusted to the change in loading caused by the pull developed as the tube enters the second stand, and a similar condition prevails in the case of the second stand after the tube enters the third stand. Curves showing this are given

Figure 8 — Distribution of loads between various stands, and relative speed of tube and rolls in final stands of a 12-stand stretch reducing mill are shown in this graph.


TUBE NO. 229
2.375" O.D. x .203" WALL x 20 FT. LG. REDUCED TO
.840" O.D. x .152" WALL x 81 FT. LG. IN 12 STANDS
M-G SET
TIME IN FRAMES AND SECONDS
TUBE ENTERS MILL
7.5 SECONDS TO ROLL 81 FT. 2 ins. LG. = 650 F.P.M. DELIVERY SPEED OF TUBE
THEORETICAL DELIVERY SPEED OF MILL (11.44" ROLL P.D.) = 748 F.P.M. (SLIPPAGE = 13%)
STAND NO. 13 AVE. SPEED UNDER LOAD = 249 R.P.M.
STAND NO. 12 AVE. SPEED UNDER LOAD = 238 R.P.M.
THEORETICAL DELIVERY SPEED OF MILL (11.44" ROLL P.D.) = 705 F.P.M. (SLIPPAGE = 8%)

in Figure 11. As a result a stable relationship between the first two stands is not achieved until the tube is being worked in one or more of the succeeding stands. The actual amount of end-thickening is therefore determined by the subsequent elongation not only of the initial unstretched portion of the tube, but also of that portion processed before a condition of constant pull is established in the first two stands. See Figure 2. A comparable action occurs as the back end of the tube leaves the various stands, wherein the development of the non-uniform wall section begins as soon as the relationship of the last two stands is changed by the varying loads of the preceding stands.

Under such conditions, the length of the non-uniform wall, or heavy end section is basically determined by several factors, namely:

1. *Motor speed characteristics.* The time required for a stable speed relationship to be established between the first two stands determines the length of tube processed before the uniform wall section is started. In the case of individually motor driven roll stands, the time element for a specific rolling schedule is principally a function of the motor speed characteristics. Rapid recovery from the impact speed drop to a steady state condition is essential on this account, and motors must be designed to meet this requirement, if end-thickening is to be held to a minimum.

2. *Center distance between consecutive roll stands.* The length of tube processed before equilibrium of rolling forces is established in the entering stands is directly influenced by the distance between consecutive roll stands. Other factors remaining equal, the length of end-thickening will vary in direct proportion to the ratio of stand spacing. It is therefore, essential in the design of stretch-reducing mills to maintain the shortest possible center distance between stands without sacrificing strength and rigidity of construction required for the tube size range and roll loads involved.

3. *Size of tube.* A change in the size of the tube being processed on a specific mill will alter the amount of end-thickening produced for an equivalent percentage of reduction in area. In the reduction of small tube sections, relatively light mill loads are involved, and a steady state speed condition in the entering stands is attained rather quickly. At the same time for a given roll diameter, the proportionately longer arc of roll contact (compared with the reduction in diameter) encountered in processing small diameter tubes reduces the amount of roll slippage, so that the full amount of tension is developed almost as soon as the pass is filled. A converse situation prevails in the case of larger tube sizes. Due to the heavier loading of the drive motors, more time is required for a stable roll speed relationship to be established in the initial stands. A greater degree of slippage is also encountered, with the result that longer heavy end sections are produced for equivalent area reductions in comparison with the smaller tube sections.

4. *Overall reduction in area of the tube.* This factor determines the final elongation of the non-uniform wall section produced before stable rolling conditions are developed in the entering stands of the mill. In general, a change in area reduction will result in a proportionate change in the length of the heavy end section. However, a study of the actual amount of end-thickening encountered over a wide range of area reductions indicates

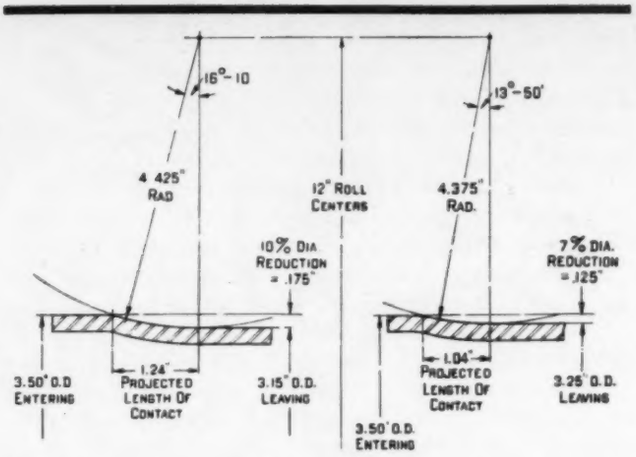


Figure 9 — Heavier diameter reductions give increased length of contact and thus increased tension, as shown by a comparison of the sketch on the left with a 10 per cent reduction per stand with that on the right with a 7 per cent reduction per stand.

that no exact relationship exists, due to the large number of variables which control the amount of area reduction produced with a specific rolling schedule. With the stretch-reducing process, area reduction can be varied either by changing the overall reduction in diameter of the tube through the addition or removal of roll stands; by changing the amount of wall reduction through adjustment of roll speed ratios; or by a combination of both procedures. With any such changes in the rolling schedule, the factors which determine the tension applied to the tube, particularly roll separating forces and roll friction, are subjected to some readjustment. In this manner the conditions which determine end-thickening may be altered without effecting a comparable change in the attendant area reduction. The effect of these variables is more pronounced where substantial changes in area reduction are made by varying both the number of roll stands and the roll speed ratios. For example, a 4 to 1 reduction may produce a 6 ft long heavy wall section on each end of the reduced tube. In comparison, a 2 to 1 reduction, involving the same initial diameter and length of tube and the same percentage diameter reduction per stand but using fewer number of stands with a higher roll speed ratio, will produce a heavy wall length of only 2½ ft on either end, despite the fact that the total elongation of the tube in each case is proportional to the ratio of the area reductions. Numerous comparisons, involving different rolling schedules and area ratios, show similar deviations from a direct relationship and force the conclusion that any determination of heavy end length for a specific rolling schedule by calculations based on area ratios alone will be only approximately correct.

5. *Diameter reduction per stand.* For the same overall reduction in tube diameter, an increase in the percentage of diameter reduction per stand will reduce the number of stands required for the reduction, and thereby shorten the length of the heavy wall section in about the same proportion. For instance, the reduction of a 2⅜ in. outside diameter × 0.148 in. wall tube to 0.840 in. outside diameter × 0.120 in. wall in a 16-stand mill with 12 in. diameter rolls, using an average diam-

eter reduction per stand of 7½ per cent will develop a heavy wall section approximately 6 ft long on either end of the reduced tube. The same reduction in a 12-stand mill, using an average diameter reduction per stand of 10½ per cent will produce a heavy end length of about 4¾ ft on each end of the tube. The reason for the difference in the amount of end-thickening is easily explained. Assuming that a stable relationship is achieved between the first two stands of the mill, by the time the front end of the tube has entered the fourth stand, the subsequent elongation of the non-uniform wall length produced up to this time will be less in the case of the shorter mill, since a larger proportion of the total reduction in area will have been made in the first three stands of the 12-stand mill than in the same number of stands of the 16-stand mill. At the same time, the increased length of roll contact, which accompanies the higher diameter reduction per stand, undoubtedly assists in reducing the amount of roll slippage encountered as the tube enters the mill, thereby permitting a stable rolling condition to be achieved more quickly. The exact location of the tube with respect to the roll stands at the time stability is established in the entering stands will vary with different conditions of mill loads, roll friction, tube speed, motor speed characteristics, etc. The assumed location is typical of the rolling schedule depicted by Figures 2 and 11 but is intended for illustrative purposes only. While the reduction in end-thickening developed by the shorter mill will be somewhat offset by the heavier loading of the individual stands and the attendant increase in time required for a stable motor speed relationship to be developed, the net gain in product yield will generally be sufficient to justify the use of the highest practical diameter reduction per stand in establishing rolling schedules for the stretch-reducing mill.

In addition to the basic determinants cited above, there are several other factors which influence the length of the heavy end section to a lesser degree. Substantial increases in the entering speed of the tube will tend to produce longer heavy end sections, since a greater length of the tube will be processed during the time interval required for the roll speed ratios to become stabilized. Temperature variations of more than 50 to 100 degrees below the normal rolling range of 1800 to 1850 F will also cause heavy end sections to be increased, due to the higher resistance to deformation of the steel under such conditions. Similarly, the higher carbon and alloy steels offer more resistance to deformation by tension, which condition adversely affects the wall reduction and end-thickening produced when this class of material is processed. Other factors, such as scale, roll wear, mill rigidity, etc., may also cause variations in the amount of end-thickening developed by a specific rolling schedule, although the effects of such items can usually be eliminated through the development of good operating practice.

FACTORS INVOLVED IN MOTOR DESIGN

The important part played by roll speed relationships in the determination of wall reduction and end-thickening requires that the motors driving the mill be designed to provide suitable speed characteristics. The maximum spread of roll speeds between the first and last stands of the mill must be sufficient not only to include the maximum area reduction to be made, but also to compensate for roll slippage and frictional losses. Actual timing of tubes in process, together with checks of motor speeds by motion picture recordings, indicates that the delivery speed of the tube is always less than the pass line speed of the last two sets of rolls in the mill. See Figures 8 and 11. The differential tends to become greater as the amount of wall reduction is increased, and roll speeds for mills designed to make large reductions must have sufficient spread between the entering and leaving stands to offset a slippage factor of 10 to 15 per cent. If the same mill is to be operated either as a conventional sinking-sizing mill or as a stretch-reducing mill, the minimum spread of stand speeds must also be small enough to handle the low ratios which feature the sinking operation. In such applications, it may be necessary to provide motors having a 3 to 1 speed range, or some means of separate voltage control for different motor groups, in order to satisfy the requirements.

Suitable means for obtaining a fine speed adjustment are required in order to set up the roll speeds to the desired ratios, and the steady state speed regulation (difference between no load and full load speed) also must be known in order that the no load setting can be adjusted to compensate for the speed drop under load. A high degree of steady state regulation is not essential for successful stretch mill operation, and in fact, is somewhat detrimental in that it complicates the problem of providing satisfactory regulation during the transition period in which the impact speed drop and recovery to the steady state condition take place. As outlined in the discussion of end-thickening, the time required for this transition must be as short as possible in order to hold the length of the heavy end section to a minimum. The means most generally used for accomplishing the desired regulation is the application of low impact speed drop motors incorporating a large moment of inertia (Wr^2), with minimum recovery from impact drop to steady state condition. This design was originally advocated on the premise that a smaller speed differential between two consecutive roll stands would occur during the recovery period with this type of motor, which in turn would minimize the effect of the compressive forces thus introduced in the tube. Actually, the amount of roll slippage developed in the stretch-

Figure 10 — Sections of stretch reduced tube. Offset in outside edge of No. 7 tube is result of improper alignment of top and bottom rolls in final sizing passes. Irregular inside contour of No. 301 is typical of wall sections above 0.350 in. where upsetting action developed by the heavier diameter reduction in the roll passes is only partially eliminated by the tension applied between consecutive roll stands.

reducing process is such that no adverse rolling condition, such as ballooning of the tube between passes, is likely to be experienced on this account, and the principal benefit derived from the use of motors with such characteristics has been in the reduction in time required for the establishment of the desired speed ratio between adjacent stands.

In view of this situation, it is possible that an improved operation could be obtained by the use of motors having a somewhat smaller moment of inertia, presuming that a faster recovery could be obtained by forcing. It is argued that the greater impact drop of such a motor would not seriously affect the progress of the tube through the mill, while end-thickening would be reduced by virtue of the quicker attainment of stable rolling speeds. However, the possibility of reducing the

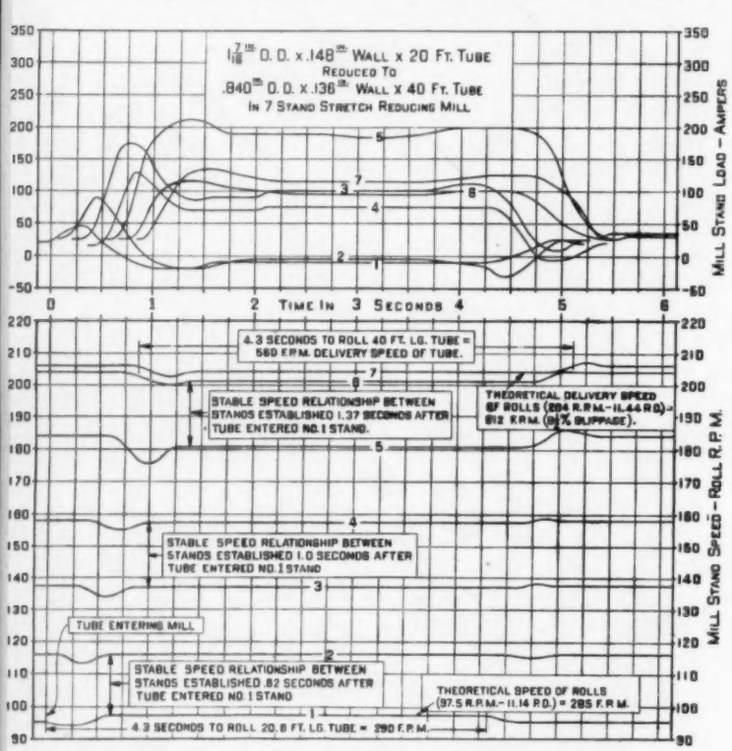

1 7/16" O. D. x .148" Wall x 20 Ft. Tube
Reduced To
.840" O. D. x .136" Wall x 40 Ft. Tube
In 7 Stand Stretch Reducing Mill
Mill Stand Load – Amperes
Time In Seconds
4.3 Seconds To Roll 40 Ft. Lg. Tube = 560 R.P.M. Delivery Speed Of Tube.
Stable Speed Relationship Between Stands Established 1.37 Seconds After Tube Entered No. 1 Stand.
Theoretical Delivery Speed Of Rolls (284 R.P.M.–11.44 R.D.) = 812 R.P.M. (31% Slippage).
Stable Speed Relationship Between Stands Established 1.0 Seconds After Tube Entered No. 1 Stand
Tube Entering Mill
Stable Speed Relationship Between Stands Established .82 Seconds After Tube Entered No. 1 Stand
Theoretical Speed Of Rolls (97.5 R.P.M.–11.14 R.D.) = 285 F.P.M.
4.3 Seconds To Roll 20.8 Ft. Lg. Tube = 290 F.P.M.
Mill Stand Speed – Roll R.P.M.

Figure 11 — Shown here are motor loads and speeds during the processing of a tube through 7 stands of the 16-stand mill illustrated in Figures 2 and 4. Note impact speed drop and recovery of each stand in relation to time.

period of transient speed regulation by this method is complicated by the fact that the amount of recovery will be increased by the greater impact drop, so that even with forcing, the total time element may be equal to or greater than the ¾ to 1 second recovery time of the higher Wr^2 motor. Another problem encountered with this type of regulation is the avoidance of overcompensation which may result from the simultaneous reduction in load on the mill. As shown in Figures 8 and 11, the relatively high impact load developed as the tube enters each set of rolls is quickly relieved in the initial stand by the tension developed as the tube enters succeeding stands. Since the reduction in load will tend to augment the effect of any forcing, it may prove difficult to level off to the steady state speed directly, in which case the time required to achieve this condition would likely be longer than that required by the high Wr^2 motor.

A more promising method of minimizing the recovery period may be found in the combination of a high Wr^2 motor with an electronic control acting directly in the field. It is possible that this type of field control will be sufficiently fast to further reduce the small recovery period of the low impact speed drop motor by forcing, while the high moment of inertia will counteract any tendency for the motor to hunt due to the combined effects of forcing and reduction in load on the mill. In the design of such equipment, it is essential that the provision of a large moment of inertia by purely mechanical means, such as flywheels or heavy rotating parts, be adopted only in cases where the capacity of the motors is restricted by physical limitations to such an extent that sufficient Wr^2 cannot be provided by the motor alone. While the impact drop can be reduced by the use of flywheels, the motor must be capable of making up the energy loss of the flywheel without introducing a prolonged recovery period or other conditions which may adversely affect the length of the heavy end section of the tube. The most satisfactory method of meeting these requirements is by increasing the load capacity of the motor whereby both impact drop and recovery time will be reduced for the same conditions of load and speed.

While several of the disadvantages encountered with respect to speed regulation can be eliminated by the use of a mill operated through a lineshaft drive from a single motor, the need for flexibility in the selection of roll speeds in the operation of the stretch-reducing mill makes such arrangements generally unsatisfactory. It is only in applications where a limited product mix is involved and ample time is available for roll and gear changes that the advantages of the lineshaft drive more than offset the disadvantages of the individual motor driven stands.

In the preparation of rolling schedules involving stretch-reducing, the selection of values for the factors which determine wall reduction and end-thickening is confined to a rather narrow range by physical limitations of the material being processed, thereby restricting the range of product which can be satisfactorily produced. The use of relatively heavy diameter reductions per stand, which is required to reduce wall thickness and advantageous in shortening the heavy end section, is effectively limited by the inability of the light wall tube sections to withstand the rolling pressures and spreading forces developed by such a reduction. Tubes having a diameter to wall thickness (D/t) ratio above 35 to 1 will collapse in the pass when reductions of 7 per cent and higher are attempted, while the ratio will be reduced to 30 to 1 if the reduction is increased to 10 per cent. Even in cases where the D/t ratio is such that the tube will not collapse, reductions above 10 per cent are considered to be impractical due to the excessive tendency for the tube to spread in the pass, thus causing overfills and shearing at the pass line. In reducing tubes over 3½ in. diameter, this condition becomes more critical and forces a gradual lowering of the maximum reduction in about the ratio of 1 per cent per inch of diameter increase.

As the tube diameter is increased, the amount of wall reduction which can be made also becomes progressively

smaller. This condition forces the use of relatively light entering walls, which in combination with the increased diameter reduces the collapse resistance to a point where the tube cannot be processed successfully. Large diameter tubes also accentuate the problem of crop end loss. In addition to involving heavier motor loads and longer recovery periods, the large separating forces necessitate the use of larger diameter rolls and bigger roll housings, which in turn increase the stand spacing and consequently, the length of the heavy end section. While a 2 in. outside diameter tube can be rolled on a 9 in. mill with a stand spacing of 9½ in., a 5 in. outside diameter tube requires at least a 14 in. mill with 14½ in. stand centers, thus producing a heavy end length, roughly 1½ times as long as the smaller section for equivalent reductions. In combination, these conditions serve to limit the maximum size tube which can be efficiently produced to about 3 in. outside diameter. On the other hand, practically all of the factors controlling wall reduction and end-thickening favor the production of small diameter sections, making the process attractive for the manufacture of product from 2⅜ in. outside diameter down to sizes as small as 0.675 in. outside diameter (⅜ in. standard pipe) with walls ranging from 0.200 to 0.080 in.

Even with the most advantageous rolling schedules, the amount of end-thickening produced is a serious problem as far as securing satisfactory yields is concerned. If the wall of the entering shell is to be either maintained or reduced by stretching, the minimum length of heavy end section will generally be at least 1½ ft on each end of the tube, while the maximum length may be over 8 or 10 ft where extremely heavy reductions are made. Under such circumstances, the rolling of short finished lengths is, of course, prohibitive. However, favorable yields can be obtained by producing finished lengths from 100 to 300 ft long depending on the overall reduction involved. While the application of the process to existing mill installations is handicapped by the fact that equipment and space restrictions prevent the production of such lengths, the provision for rolling long lengths can be readily made in new mill installations, and it is through the construction of such mills that the stretch-reducing process will be put to most effective use.

DISCUSSION

PRESENTED BY

PAUL FLAUTZ, Assistant Superintendent Hot Mills, Pittsburgh Steel Company, Pittsburgh, Pennsylvania

S. W. STOUFFER, Jones and Laughlin Steel Corporation, Pittsburgh, Pennsylvania

H. R. McLAREN, Assistant General Superintendent, The Timken Roller Bearing Company, Canton, Ohio

NEWELL HAMILTON, Steel Mill Superintendent, Babcock & Wilcox Tube Company, Beaver Falls, Pennsylvania

G. E. STOLTZ, Manager, Metal Working Section, Westinghouse Electric Corporation, East Pittsburgh, Pennsylvania

LOUIS MOSES, Superintendent Rail Mill and Roll Department, Bethlehem Steel Company, Sparrows Point, Maryland

A. L. THURMAN, Assistant to the Vice President, The Aetna-Standard Engineering Company, Youngstown, Ohio

Paul Flautz: In one of the early graphs, was there a difference shown in diameter of the tube entering the second pass, as compared with that coming out of the first?

In other words when the tube is under full stretch, is there a difference in tube exit diameter from the first pass as compared to the entering diameter of the second pass?

S. W. Stouffer: We have tried to measure the diameter difference between the successive stands, and while there probably is some diameter reduction, the amount is so small that we cannot measure it. Apparently, practically all the reduction takes place in the wall thickness rather than diameter.

Paul Flautz: In early reports on stretch mills, on which Stewart and Lloyd's did considerable work, it was demonstrated that when the tube was stretch-reduced, the diameter decreased in proportion to the wall thickness, or the wall thickness decreased in proportion to the diameter during stretching action.

If, in your experiments, you have not found where any diameter reduction occurs from stretching, where then does it take place? Is the diameter reduction confined to the contact area of the roll pass?

S. W. Stouffer: Yes, diameter reduction is produced in the roll pass, while the reduction in wall takes place between stands.

Paul Flautz: It is difficult to understand why more diameter reduction can be made with a reducing mill which keeps the tube in tension as compared to a conventional mill where there is no tension, unless the tube diameter is actually reduced either within the roll pass or between the roll pass from the stretching action as well as the crushing action of the rolls.

S. W. Stouffer: The explanation of this feature lies in the fact that the usual limiting factor in diameter reduction per stand on the conventional sizing mill is determined by the squaring up of the inside of tube section under the compressive forces introduced by heavy reductions. In the stretch mill, the tension forces a greater portion of the metal flow into elongation. At the same time, a cumulative build up of the wall in successive stands, a definite factor in producing square inside contour, is eliminated with the use of tension.

H. R. McLaren: In the first place, there are a great number of variables in the operation of this mill, and I don't feel it has much utility from the standpoint of the mechanical tube mill and, therefore, the economics of this process restrict it entirely to a method of making small diameter pipe.

S. W. Stouffer: I believe your question can be answered in this way. We found that in tension reducing,

the uniformity of wall of the finished tube was better than the uniformity of wall of a tube reduced in an ordinary sinking mill.

In other words, the tension which we applied between stands tended to overcome any tendency for the inside of the tube to square up. I might also point out, however, that no claims are made for improvement of wall concentricity. This factor still depends on the uniformity of wall of the tube entering the mill. We are not going to correct eccentricities merely by stretching, but we do feel we can hold the uniformity with which the tube enters the mill by the use of tension rolling. Generally speaking, this is not done in conventional sinking mills.

H. R. McLaren: That was not quite what I meant. What I meant was that with the large crop loss, not considering any other variables, the method is definitely not going to be economical for the purely mechanical tubing mill. As such, then, it has to be used to produce a small diameter pipe. What are the economics of this process? You still have to compete with the Fretz-Moon process.

S. W. Stouffer: We brought out in the paper that long lengths must be produced for economical operation.

H. R. McLaren: What about a 400 ft tube?

S. W. Stouffer: We figure that finished lengths from 250 to 350 ft are possible using a stretch mill. We feel that reductions as high as 6 to 1 can be made in a properly designed mill, since as far as the quality of the finished tube is concerned, the overall reduction is not limited as it is in the sinking mill.

H. R. McLaren: But that means if you start with a 30-foot small tube which is the maximum, approximately 180 ft is the maximum finished length you can make. On top of that you have to crop about twelve feet.

S. W. Stouffer: We are assuming that we can start with a longer tube.

H. R. McLaren: We can then weld them together. There is another point that I would like to know. What is the wall variation, above that normally obtained by the difference in roll friction from the beginning to the end of an order? In other words, the roll surface is one thing that varies on large orders. That would evidently produce a different stretch condition. What wall variation can you expect on a large order, and I mean an order running over a period of several days? Could you hold it constant enough?

S. W. Stouffer: You can control the wall variation within reasonable limits by control of your roll speeds.

H. R. McLaren: You mean you have samples from the middle of the tube all the time?

S. W. Stouffer: Even though the tube is rolled 250 or 350 feet long, it will still be cut up into 20 or 30-foot pieces which will permit midsection checks on the wall. We anticipate that, following gage checks, you can adjust roll speeds and hold the wall to the specified nominal gage. If roll wear gets too bad, of course, you will not be able to hold the outside diameter tolerance and section and the rolls will have to be changed.

H. R. McLaren: You are also going to have the factor of a rolling this week and a rolling next week or next month, and you are going to have a difference between one rolling and the next. Therefore, the setting is going to have to be tabulated, but still that setting will not bring the same wall that it did last week. That is true, is it not?

S. W. Stouffer: That is possible.

H. R. McLaren: So, therefore, you are going to have to re-establish the correct roll speeds for that particular job?

S. W. Stouffer: I see your point. Stretch mill operation will not be feasible for producing small orders of the type encountered in the mechanical tubing business. Assume that you are required to roll twelve or fifteen tubes for a single order. In all probability it will take that many tubes to get the mill set up to roll the finished length and nominal wall that you want.

H. R. McLaren: As the wall of the tube varies from the same diameter reduction, is the lineal change of the wall a constant or a variable? In other words, if you were to go from 0.100 in. to a 0.300 in. wall in small tubes, and if your wall change on the 0.100 in. wall was 0.030 in., would you then expect the change of 0.030 in. on the heavier wall?

S. W. Stouffer: No, you would have to re-adjust your roll speeds for every change in wall section and reduction.

H. R. McLaren: This is just my point. What would you expect if you were running carbon steels and stainless?

S. W. Stouffer: We tried to roll some stainless tubes without much success. The principal difficulty seems to be that the tensile strength in the case of stainless is much higher than on carbon, and we were not able to obtain uniform wall reduction on this grade of steel.

H. R. McLaren: That merely brings out this other thought. If you have extra strength for any reason, heavier wall or higher strength material, you do not get the same wall change as another tube of less strength and thus roll speeds have to be changed depending upon the changed strength of the material.

S. W. Stouffer: Yes, a change in steel grade or quality would take another speed set-up.

Newell Hamilton: One thing that comes to mind is the question of roll pass design. I notice that no mention of it was made in the paper. Do you use approximately the same opening on the sides of the pass as is used on the conventional sinking mill roll?

S. W. Stouffer: We found we had to go to a slightly higher ratio of the cutter diameter to the actual depth of the pass in the case of the stretch mill. In ordinary sinking mill practice, a ratio of 1.04 or 1.05 is generally used, whereas we had to go up to about 1.08, and in the 10 per cent diameter reduction to about 1.10. In other words, it became necessary to allow the tube to spread further in order to get more reduction. Instead of taking 3 per cent reduction in each pass as in the sinking mill, we found we had to go up to 8 and 10 per cent in order to get enough grip on the tube to stretch it. As we went up in our diameter reduction, in other words as we took a heavier bite on the tube, we had to throw additional flare into the pass in order to avoid over-filling between the rolls.

Newell Hamilton: My next question, which I know is of importance to any operator, concerns your experience with roll wear on these excessive diameter reductions.

S. W. Stouffer: You can expect that roll life will be shorter than with conventional sinking mill practice.

After all, in the entire area of contact of the roll with the tubes, the roll is traveling at a much faster rate than the tube, and this slippage is bound to wear the rolls faster.

Newell Hamilton: What happens then is as you go down in diameter in each successive stand, you present a smaller and smaller ratio of diameter to thickness in each reduction.

S. W. Stouffer: Yes, the D/t ratio decreases as the tube progresses through the mill. The diameter is reduced at a much faster rate than the wall.

Newell Hamilton: As I understand the paper, you take equal percentage reductions per stand. Is that correct?

S. W. Stouffer: Yes, we ran a series of rollings with the graduated reductions; in other words, we took a small reduction on the entering stand and increased it as the tube diameter decreased. We found that it made little or no difference in the amount of wall reduction or in the performance of the mill. So we arbitrarily set and used an equal percentage in all stands during the entire test series.

Newell Hamilton: All of my questions are based upon experiences that we have had with this same problem but with slightly different equipment. Our mill has variable speed motors on it and was built about 1924. At the present time we do not use very much tension in our set-ups. We have experienced temperature variation from the first to the last stand, which adds to the problem of making satisfactory reductions.

S. W. Stouffer: We, too, have had some indication of this factor in our rollings. I don't know whether you were able to see it on the graph of the tube wall shown as Figure 3, but the back end of the tube tends to be slightly heavier in wall than the front end. We attribute this to the fact that the back end is generally somewhat colder than the front end. However, with the improved re-heating furnaces, which are now being designed, we feel that this objection can be overcome.

G. E. Stoltz: In thinking over some of the questions that have been asked Mr. Stouffer, it occurred to me there might be some advantage in comparing this method of rolling tubes under tension and pressure with tandem rolling of strip steel.

We all know that great progress has been made in the rolling of strip, particularly, cold-rolled strip. I think it is the consensus of opinion that tension is one of the very important factors that has made this possible.

In rolling flat strip, the rolls can grip the metal quite firmly and considerable tension is developed. The greater the tension, the less roll pressure is required. For this reason it is general practice to use as much tension as possible.

It is necessary to have some pressure, both in the flat-rolled products and tubes to control the reduction and to stabilize the tension. In order to avoid crushing a tube, there is a limit as to the value of the pressure that can be used. With the restriction in roll pressure it is necessary to limit the tension, so that a greater number of stands are required than are needed for similar work on strip steel.

I would like to ask Mr. Stouffer if it is their practice to determine ahead of time what drafts they propose to make and then set the speed of these motors at their proper values?

It seems to me that with such close spacing of stands and such small reduction per pass, it would be difficult to know when the proper draft and correct tension are being used.

Some years ago we designed the electrical equipment for a structural mill which had three sets of rolls working on the metal. The main set of rolls worked on the web of the universal beams, and in the same housing was a set of vertical rolls that reduced the outside of the flanges. Twelve feet from these two sets of rolls was another pair of horizontal rolls that maintained the shape of the edges of the flanges.

This was a reversing mill taking several passes on each piece, and we found it necessary to set the screws of each of these 3 pairs of rolls so as to always elongate the beam uniformly throughout its entire cross section. This could not be accomplished by depending upon the operator to set each of these 3 pairs of rolls correctly before each pass and an automatic screwdown was installed.

The roll designer developed the correct setting of each pair of rolls for each pass. This information was incorporated on a blueprint and given to the roller, so that a set-up could be made on the automatic screw mechanism previous to starting rolling any particular section. This has worked out quite successfully. While it should not be necessary to have automatic screwdown settings of mills rolling tubes, I would think it would be necessary to predetermine the setting of the rolls to assure proper reduction and tension.

S. W. Stouffer: When we started out, the actual amount of wall reduction which we could expect was indeterminate, we didn't know how much we could get, if any. We began on the basis that by gradually increasing the relative speeds of the rolls in consecutive stands, we would obtain some reduction in wall. The method used to set roll speed schedules for the initial rollings involved the calculation of tube area in each pass and then determining what we called a base roll speed which would theoretically pass a constant volume of metal through each set of rolls, assuming that the entering wall thickness was maintained throughout the entire mill. In practice, it was necessary to increase the relative roll speed ratios slightly in order to maintain the initial wall. To obtain a reduction in wall, we merely increased the base speeds in geometric progression, i.e., the speed of the second roll stand was increased by 1.05; the third stand by 1.05×1.05; the fourth stand by $1.05 \times 1.05 \times 1.05$, and so on.

We now have indications of about how much wall reduction can be obtained with a given speed ratio, and assuming we wanted to set up a rolling schedule, say to get a 10 per cent wall reduction, we would calculate the tube areas in each stand, predicated on a uniform amount of wall reduction between each stand, and include a slippage factor, which also has been fairly well determined. In addition, we would also figure the element of change from no-load speed to full-load speed of the motors.

With all these variables, it would be practically impossible to set up a speed chart for every set of rolling conditions and hit it on the nose every time. We would have to make adjustments after the first or second tube

was rolled and possibly ten or fifteen tubes would have to be rolled before we could get the wall reduction desired.

After a set of rolls has been in service for several turns, there is no doubt that the wear of the rolls will change the amount of wall reduction obtained. The only method we know which would correct this condition would be to adjust the speed of each roll stand until the desired reduction was produced.

It is practically impossible to say that we are going to increase the speed of any one stand five per cent and correct the wall condition, because there is so much slippage between a roll and tube there that the adjustment of any one roll speed will not materially affect the product. It is the combination of all rolls acting simultaneously that permits wall reduction, and consequently all rolls must be adjusted for changes in section.

In the experimental rollings, it was impossible to get any wall reduction at all if less than six stands were used. There was not enough gripping power available to stretch the tube.

Louis Moses: In rolling mills the term, sizing, has sometimes been applied to the finishing pass of a system of reductions, but not generally. Here it is used in the overall sense of sizing a large blank down to the dimensions of the desired end product. Its use is probably a derivation from the sizing rolls used to size and round up bench drawn butt-weld and lap weld pipe. The operation described is none the less a rolling operation but with the important difference that a hollow, and not a solid, cross sectioned piece is being reduced in area with an increase in length, and the introduction of stretching to aid elongation and correct wall thickening.

In rolling processes, however simple or complex the section being rolled, the one inviolate law which applies to all, and at all stages, is that metal will flow in the path of least resistance. All of the skill and accumulated experience of roll designing can be summed up in that statement. The fly in the ointment is where that elusive factor of least resistance is going to show itself. It surely does bob up unexpectedly. There are so many circumscribing influences to consider that the matter is comparable to the common law of our jurisprudence which must be interpreted by the tons and tons of law libraries of a nation. However, all of the experience applicable to rolling solid cross sections is found to be unequal to the needs of rolling hollow sections.

With a demand for seamless tubing in small and popular sizes, it was well known that tubing walls tend to thicken when reduced between rolls, but there was little or no reliable data upon which to engineer and schedule an operation of what is virtually a pioneering project. So an admirable engineering approach was made, which is little short of a scientific attempt to find the governing factors. The paper reflects a long and controlled program of research which the author describes and reduces into terms of evaluation of often conflicting phases and summation of cause and effect.

In a continuous butt weld mill, the drafts taken are seldom more than 4 per cent of tube area, but at such reductions, and as a result of the operation of all stands, the wall thickness of some sizes of pipe will increase up to 0.010 in. from entering skelp gauges. This is easily controlled by regulating the skelp gauge, but on the subject mill no such simple correction is possible and the metal must be induced to flow to the desired sizings.

Two continuous butt weld mills are in operation side by side. One is arranged with its stands driven from a common drive shaft, the other is equipped with individually driven stands. It is found that the little regulation of wall thickness demanded is more readily accomplished by limited amounts of stretch in the latter mill. Conceivably, the rolls of the geared mill could be arranged to do so but this entails considerable mechanical difficulty and even if equal efficiency were so provided, the arrangement would be correct for only one size and weight of pipe and would not care for any other variations. It is thus easily appreciated that a variable speed at each stand is a prime requisite, not only from ordinary considerations but to effect the necessary stretching and to serve the many sizes within the range of the mill.

In a sense, the welding stand of a continuous butt weld mill offers a comparison to Mr. Stouffer's problems. It might be thought that when a good weld is not coming through, and all other things equal, a widening out of the skelp would induce additional pressures to form a better weld. The introduction of more stock in such manner, over and above well defined limits, would cause caving. In other words, the formed tube would not offer sufficient "columnar" resistance in its walls to hug the groove walls any tighter but would simply tend to fold against itself. Similarly, and without considerations of stretching, too great an amount of work, particularly on light walled tubing, will cave the sections in any reducing pass, and must be rigidly guarded against.

In considerably greater degree the same considerations were confronted in attending the maximum reductions possible in any stand of the stretch mill, this in turn being a measure of roll grippage action to effect stretching, and all factors being controllable. There are thus two main divisions of this process, the ultimate reduction of area between top and bottom rolls, and the correction of wall thickening by stretching between stands.

It is well known that side work on roll grooves has pronounced effects on power consumption and ability of the constricted pass to pull the bar through. Analysis of such conditions is frequently made by projecting the contact area, this naturally including the length of contact arc at any one point. By assuming 10 per cent work on 1½ and 3 in. circles, it is found the projected contact area of 14 in. rolls varies as 1.50 to 1.00, whereas the length of contact arc is as 1.00 to 3.00. Ratios expressed in terms of circle dimensions squared against inches or square inches are as follows:

Length of contact arc

3^2 : 2.57 in. = 1 : 0.286 — 100 per cent

$1\frac{1}{2}^2$: 1.95 in. = 1 : 0.866 — 302 per cent

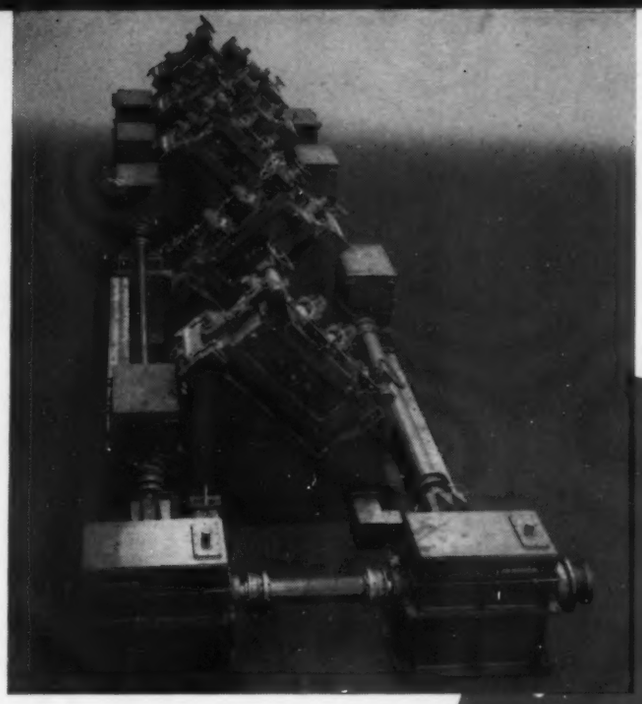
Projected contact area

3^2 : 11.15 sq. in. = 1 : 1.23 — 100 per cent

$1\frac{1}{2}^2$: 4.06 sq. in. = 1 : 1.81 — 148 per cent

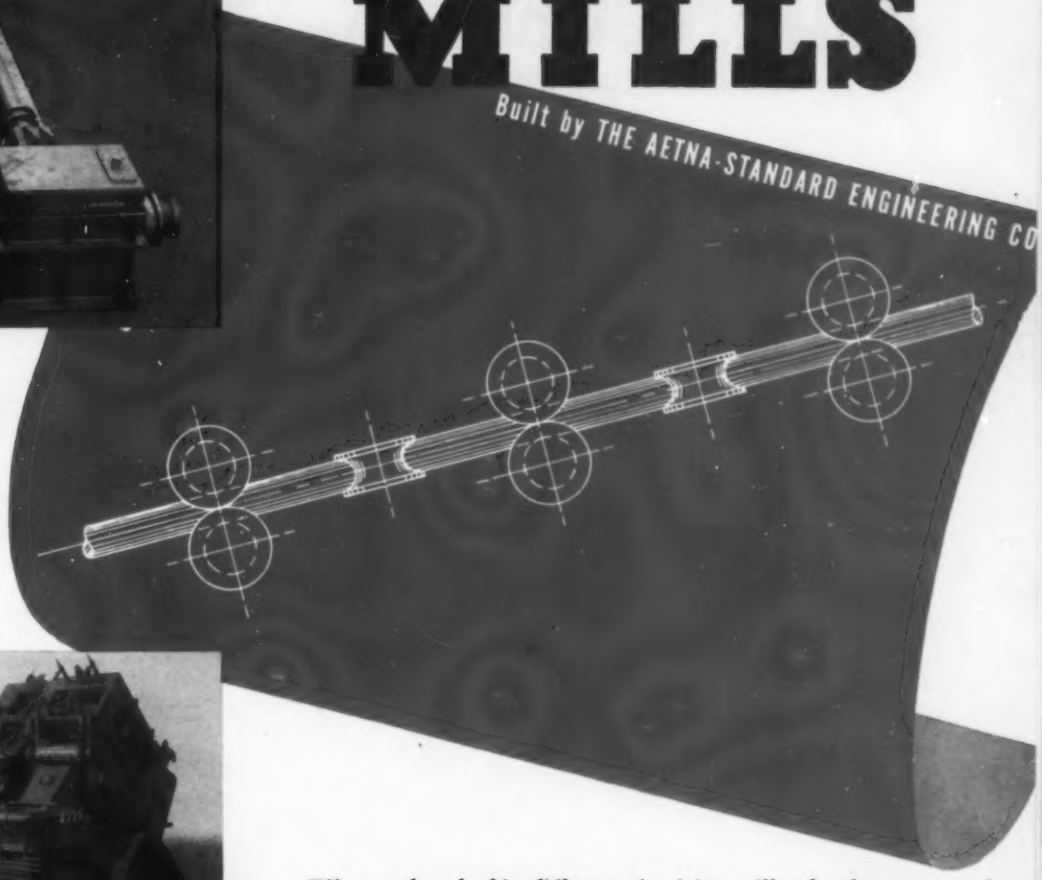
A solid bar can be pulled apart between stands of a tandem mill if sufficient pull is exerted and sometimes occurs on rather large sections of a rod mill. As tubes

(*Please turn to page 104*)



SIZING MILLS

Built by THE AETNA-STANDARD ENGINEERING CO

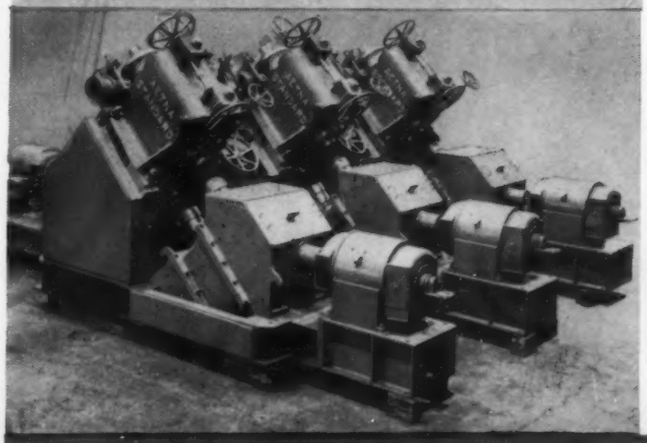


Aetna-Standard builds mills for sizing buttweld, lap weld, or seamless from 3/8" O. D. to 24" O. D. Aetna-Standard has two types of sizing mills . . . closed housing and overhang rolls.

Top—7-Stand sizing mill—28" dia. rolls for 12" O. D. tubes.

Above—3-Stand sizing mill—18" dia. rolls for 5" O. D. tubes.

Bottom—5-Stand sizing mill—24" dia. rolls for 8 5/8" O. D. tubes.



What makes the big difference in sizing mills of today compared with sizing mills of 15-20-25 years ago?

Now all shafts for rolls and drive are mounted in anti-friction bearings to maintain alignment of mill. Backlash is eliminated by use of universal spindles for connecting roll shafts to drive. A centralized grease system for the mill shafts and a circulating oil system for drives reduce maintenance and "down time" to a minimum. Another low maintenance factor is the heavy, rugged construction and the application of renewable hard liners on surfaces subject to wear.

These and other improvements in design make today's sizing mills much more efficient than the old models. Much closer O. D. tolerances can be produced and maintained. Roll adjustments have been greatly simplified, which reduces "down time" and manual labor.

All of which adds up to increased production, closer tolerances, better quality, and lower costs.

Aetna-Standard, exclusive manufacturer of seamless tube mills, makes more sizing mills than all other companies combined. Ask for sizing mill data based upon your requirements.

THE AETNA•STANDARD ENGINEERING COMPANY

YOUNGSTOWN, OHIO

DESIGNERS AND BUILDERS to the Steel, Non-Ferrous and Chemical Industries.

ASSOCIATED COMPANIES:
BEAD, WRIGHTSON & COMPANY, LIMITED, THORNABY-ON-TEES, ENGLAND
JOHN INGLIS COMPANY, LIMITED, TORONTO, ONTARIO, CANADA

BUSS FUSETRONS

will provide

BURNOUT PROTECTION

for COILS—SOLENOIDS—TRANSFORMERS

Simply—Inexpensively—and eliminate costly and troublesome replacement jobs.

Here's actual proof:

Says the Electrical Engineer of a large midwest company. (Name on request.)

"We were having trouble with solenoid coils that operate remotely controlled DC circuit-breakers. For mechanical reasons the breakers sometimes failed to close and when they did the solenoid coil burned out.

"New coils cost $36.00 and in addition we had the trouble and expense of having a man manually operate the breaker 24 hours a day until the coil was replaced.

"We tried small circuit-breakers to protect the coils but they failed. A size small enough to protect did not have enough time-lag to let the coil operate.

"Then we installed 4 ampere 600 volt Fusetrons. They completely solved our problem. The solenoid coils no longer burn out."

BUSS

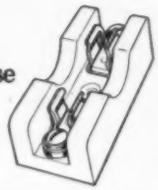
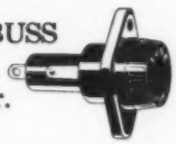
Eliminate Shutdowns–Keep Things Running

The solution is simple with Fusetrons

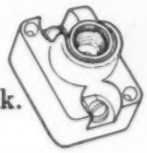
To safeguard Coils, Solenoids, Transformers, etc., the protective device must have a time-lag long enough to hold normal starting currents or harmless overloads. Yet it must open to protect, should something go wrong.

Fusetrons because they combine a fuse with a thermal cutout can give this kind of protection and prevent burnout of such apparatus.

HERE'S ALL YOU NEED TO PROTECT COILS, SOLENOIDS AND TRANSFORMERS.

A Fusetron of proper size, plus a fuse block—  or a BUSS fuse-holder. 

On voltages up to 125, the same accurate, dependable protection can be provided with

a proper size plug Fusetron or a Fustat, plus a fuse block. 

Why risk a costly and troublesome repair or replacement job—and take a chance crippling plant or building operations, when Fusetron protection is so simple and inexpensive?

What is the FUSETRON?

The Fusetron is a Dual Element device—a Fuse to which is added a Thermal cutout.

The result is a fuse with tremendous time-lag and much less electrical resistance.

Fusetrons have the same degree of Underwriters' Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to the same dimension as ordinary fuses, Fusetrons fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere in both 250 and 600 volt types. Also in temper-resisting type (Fustats) for 125 volt circuits.

Their cost is surprisingly low.

Fusetrons Give Many Other Kinds of Protection Heretofore Not Available

Fusetrons do everything fuses do, as is confirmed by the Underwriters' Laboratories Label, and in addition . . .

★ Provide simplest way to stop burnouts from single phasing. ★ Entirely wipe out needless blows caused by motor starting currents or other harmless overloads. ★ Give thermal protection to panelboards and switches. ★ Prevent needless blows caused by heating in panels and switches. ★ Permit use of larger motor or adding more motors on circuit without installing larger switch or panel. ★ On new installations, proper size switches and panels can be used instead of oversize. ★ Protect motors against burnout. ★ Give double burnout protection to large motors. ★ Make burnout protection of SMALL motors simple and inexpensive.

Get All the Facts

Get Better Protection • Send the Coupon Now

Don't risk avoidable losses. One burned out solenoid—or one needless shutdown—or one destroyed panel may cost you more than replacing every fuse with a Fusetron.

You simply protect your pocketbook by installing Fusetrons throughout the entire electrical system.

BUSSMANN MANUFACTURING COMPANY
University at Jefferson • St. Louis 7, Mo.
(*Division McGraw Electric Co.*)

FUSETRONS

Sold Through Wholesalers

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Bussmann Mfg. Co., University at Jefferson
St. Louis 7, Mo. (Division McGraw Electric Co.)

Please send me complete facts about BUSS Fusetrons.

Name_____

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Company_____

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City_____ State_____

(*Continued from page 100*)

become smaller in diameter, the section more nearly approaches the properties of a solid section. Therefore, small tubes can be more readily pulled apart than the larger tubes, by reason of the relatively tighter grip of the rolls on the small sizes and as the latter more closely approach solid section elements. There is also the logical consideration of variation in total strength. For instance, a 1 in. standard pipe has about 0.33 sq in. of material as compared with 1.00 sq in. of a 2 in. pipe. The larger pipe thus has three times the total resistance to pulling apart.

Over the past several decades, the electrical manufacturers have provided motors with ever increasing betterments of inertia, as applied to high speed continuous mills of all types. The operation of the stretch-reducing mill appears to offer a further challenge to the motor builder as well as to the design of the connecting drive. Perhaps the application of a motor to each roll, as in some large mills, without intervening pinions, and motors designed with armatures small in diameter and long in length, would be a practical suggestion.

A. L. Thurman: Due in part at least to the result obtained from the tests described by this paper, new continuous tube mills, both large and small, are now under construction. It is hoped that as a result of recent war developments, such as the B-29 turret and gunfire control, the electrical manufacturers will be able to supply a new, powerful, super-sensitive speed regulator for improved operation of these mills, and that the objectionable heavy end sections described by the paper can be cut to a minimum.

Much of the success of this type of mill is dependent upon the electric equipment, and the tests described by this paper will serve as a guide for improved electric equipment for these new tandem tube mills. Familiarity with the problems of the tandem tube mill will show they bear little relationship to the problems which have been solved in the improved performance of tandem sold strip mills. If the tubing could be produced in continuous form, the requirements of the electric equipment would be very closely allied to the problem involved in tandem cold mills, but with the tubing being produced in relatively short lengths, the electrical application problem has an entirely different aspect.

As indicated by the paper the operating problems would be extremely simple if each individual motor speed could be maintained at an absolutely constant preset value regardless of load. Since, however, with any d-c motor there will be at least an instantaneous speed drop with the application of load, there will be at least a brief period of transient speed change which contributes to the heavy end sections described by the paper. A practical compromise which may be in the realm of possibility, considering the present state of the art of electronic speed control, would be to let the drop in motor speed serve as a signal to the speed regulator to call for some slightly lower speed than the no load speed of the motor, and then to maintain that speed until the tube leaves the mill. This type of speed change would be a close compromise to the ideal and the period of transient speed change would be cut to a minimum.

Low impact speed drop motors with high Wr^2, low armature reactance and resistance, have been used as a compromise to the above characteristics. For a suddenly applied constant load such motors might provide adequate performance, but as the charts presented by the paper indicate, the stand motors go through a cycle in which there is first only friction load, then a high peak load, and finally a reduced constant load.

The paper indicates that due to the rolling schedule set up on the 16-stand, tandem tube mill, no ballooning of the tube between passes would occur. It is true that if the rolling schedule is such that the relative overspeed between stands is sufficient, then actual ballooning obviously could not occur; but, at least during the instant of load change, the tension between the two stands involved will be decreased to the point where the portion of the tube between these two stands will have a considerably different cross sectional area from that portion of the tube which is in the stands after stable conditions have been obtained. Thus, the low impact speed drop motors not only reduce the time required for the establishment of stable conditions, but also provide for improved performance by more nearly maintaining the relative tension desired between the two stands in question. A standard motor used for driving two stands of such a tandem tube mill would have such a high impact speed drop that ballooning might even be possible in spite of the high relative overspeed between stands and the time required for stable conditions to be obtained would be so long as to increase the length of the heavy end section beyond any acceptable limits.

As a good reference on this problem, the paper "Speed Stability of Motors for Continuous Mills" presented by Messrs. Crever and Linville at the 1946 spring meeting of the AISE in Chicago is highly recommended.

"THE MODERN STRIP MILL"

We continue to receive requests for the above book which we are unable to fulfill as our supply is exhausted. If you have an extra copy we can sell it for you. Write:

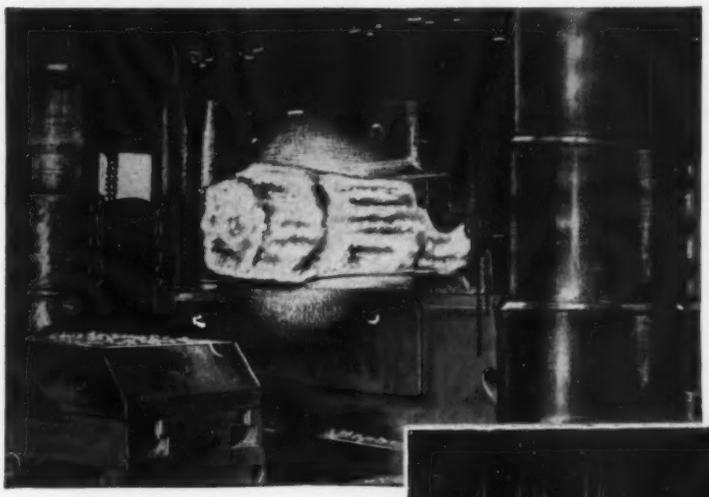
ASSOCIATION OF IRON AND STEEL ENGINEERS
1010 Empire Building
Pittsburgh 22, Pennsylvania

CORRECTION!

On page 69 of the January issue of Iron and Steel Engineer, a photograph of a cold mill was inadvertantly captioned "Close-up view of Sendzimir mill." This should have read "Close-up view of Uni-Temper mill."

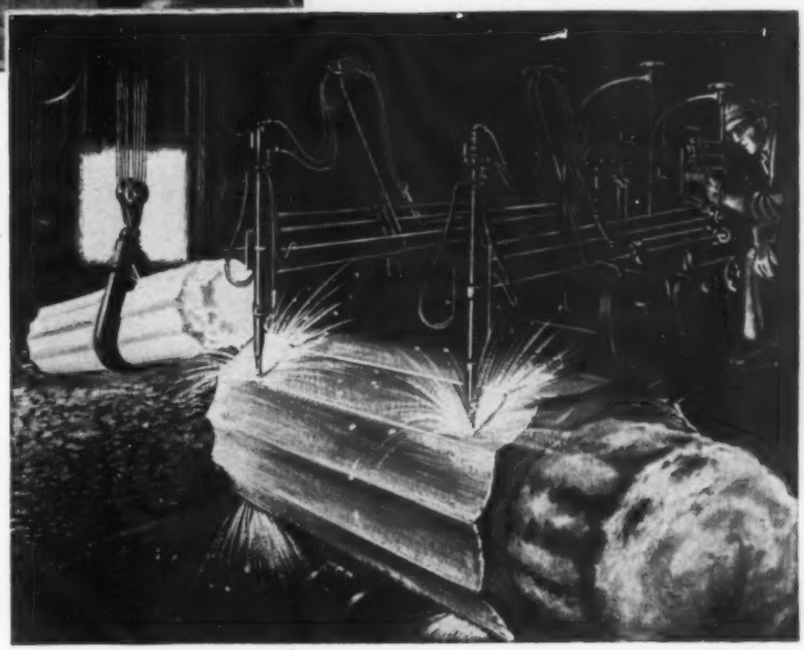
Association of Iron and Steel Engineers

STILL LOOKING INTO THE FUTURE



YESTERDAY...

"Press Cropping" Ingots Was Advanced Technique. Until just recently, steel men used this method to crop or trim ingots preparatory to forging.



TODAY...

It's "Flame Cropping"! Now, hot tops and bottoms of large fluted ingots of even the toughest alloy steels are quickly and neatly cropped in one operation by an ingenious flame cropping machine. Developed by Airco as a service to the steel industry, this machine cuts operating time from hours to minutes...slashes costs . . . helps meet today's demands for high standards of quality.

and TOMORROW...?

Airco's research and development staff will continue to contribute to new and better ways of steel production with the same foresightedness that has always characterized their efforts to provide new tools for industry.

Airco's Technical Sales Division is at the call of steel men in applying Airco processes in the solution of their problems. For additional information, get in touch with your nearest Airco office or write: Air Reduction, 60 E. 42nd St., New York 17, N. Y. In Texas: Magnolia Airco Gas Products Company, Houston 1, Texas.

AIRCO **AIR REDUCTION**

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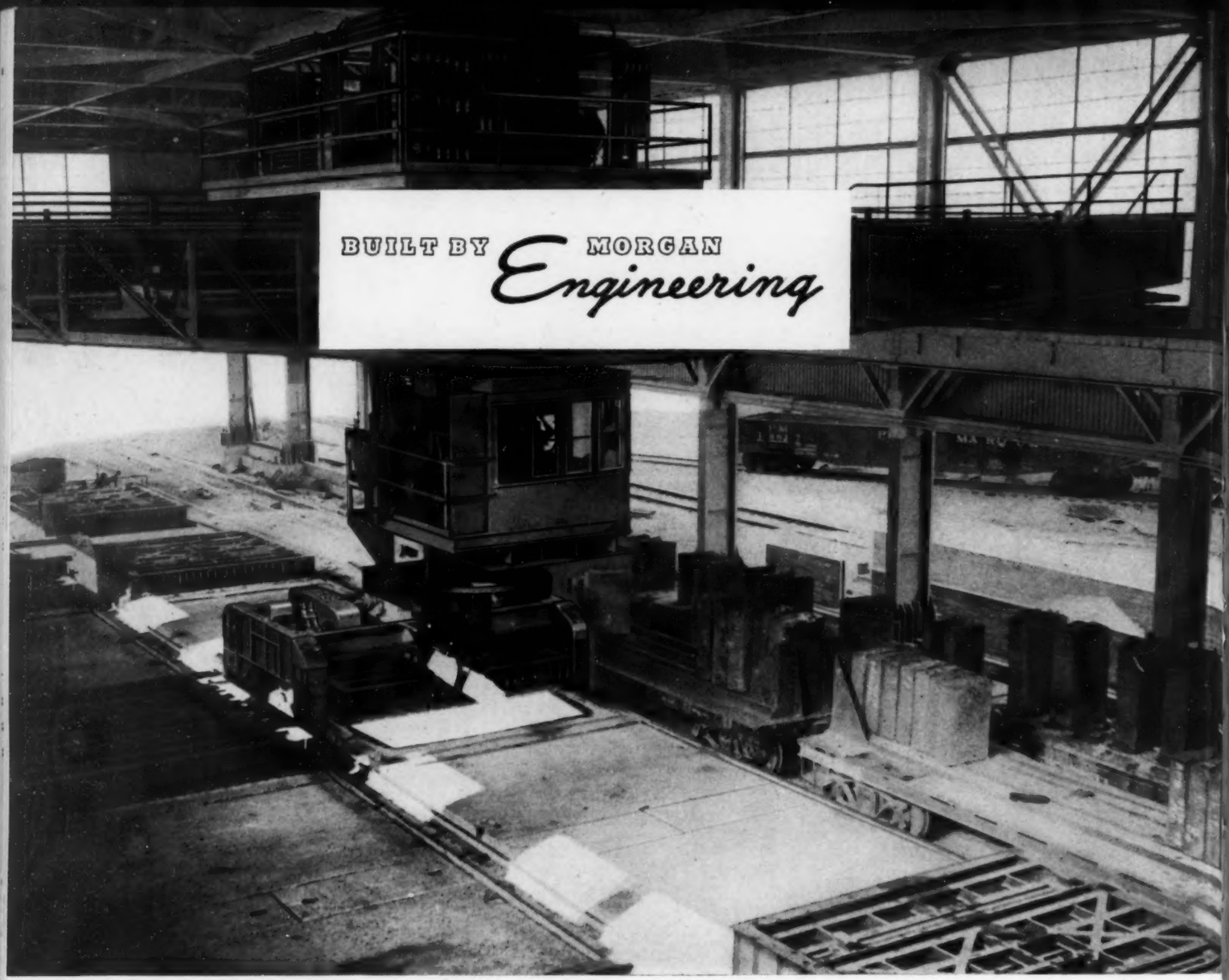
ORIGINATORS OF MODERN OXYACETYLENE METHODS FOR THE STEEL INDUSTRY



MORGAN 10-TON SOAKING PIT CRANE

HANDLING SLAB INGOTS IN A WEST COAST STEEL PLANT

Illustrated is a Morgan 10-Ton, 7-Motor, 81′ 0″ Span Soaking Pit Crane with 15-Ton Auxiliary Hoist. Morgan superiority of design and construction is built into every part to insure many years of profitable service. It is equipped with fabricated welded trolley and bridge trucks and anti-friction bearings throughout. Trolley is of the worm operated type which simplifies the construction and lowers the cost of maintenance.

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NEWS SUPPLEMENT FEBRUARY, 1947

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Personnel
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Iron AND Steel ENGINEER

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WEIRTON STEEL COMPANY BEGINS OPERATION OF 66-INCH HOT STRIP MILL INSTALLATION

▲ Weirton Steel Company's new 66-inch hot strip mill rolled its first steel on January 29, 1947. Eight hundred men worked on round-the-clock shifts to make the record change-over. After they tore out the old equipment, they excavated more than 15,000 cubic yards of earth and poured more than 5,000 cubic yards of quick-drying concrete — enough for the foundation of a 20-story building. They laid thousands of feet of electric wire and conduit and pipes for water and oil before they could assemble the giant housings and rolls of the new mill.

The 66-inch mill is a four-high continuous mill which rolls out thick slabs of steel into long coils of thin-gauge metal that is made into tin plate or steel sheets of various kinds. The new mill is expected to produce at least 135,000 tons of hot rolled strip per month, an increase of approximately 50 per cent over the average production of the 48-inch mill.

The 48-inch mill established a production record which steel men consider remarkable. Built for a theoretical capacity of 30,000 tons per month, its actual production almost doubled this figure by the end of its tenth year and almost tripled it in each of the last three years. From August 1927 to the shutdown on last January 13, 1947, the 48-inch mill rolled approximately 12,000,000 tons of steel.

Weirton men attribute this performance partly to improvements that have been made through the years and to other factors but chiefly to the fact that the mill's capacity was greatly underestimated because it pioneered in an entirely new field of steel production. This was the practice, now widespread in the steel industry, of starting a thick slab in one end of a series of mills and rolling it continuously in one direction through mill after mill until it emerged as a coil of thin steel.

The new 66-inch mill will increase production primarily by increasing the rolling speed thus making it possible to roll larger slabs. There will be other outstanding improvements, however, such as a more precise control of temperatures, which is highly important in steel production, and high efficiency in the handling of coils.

The "raw material" of the 66-inch mill is the slab which is rolled from the ingot on Weirton's 40-inch blooming mill. In order to conserve as much heat as possible the slabs, which range up to 7500 pounds in weight, are conveyed rapidly to the hot mill's heating furnaces where they are brought to rolling temperature.

NEWLY ACQUIRED MINES AUGMENT J&L ORE SUPPLY

Jones and Laughlin Steel Corporation, now getting most of its ore from Minnesota, recently leased the Benson Mines, a tract of 3100 acres on the western slope of the Adirondack Mountains in St. Lawrence County, New York. During the war the government built a complete, large scale plant at Benson for crushing and processing 2,400,000 tons of raw ore each year into 800,000 tons of concentrates, a product containing more than 60 per cent iron. This plant was purchased by J & L for $4,000,000 and it is planned to spend $2,000,000 for further improvements.

Hard rock is crushed fine to release the iron ore, then passed through the concentration plant to separate ore from waste. The concentrates are then mixed with powdered anthracite coal and fused into sinter resembling black, metallic clinkers. About 50,000 tons of the low sulphur, sintered ore is shipped per month to J & L plants where it is mixed with Mesabi and Michigan ores. This provides about one-fifth of the company's annual needs at capacity operation.

In the rolling process, the slabs pass through four roughing mills, a scale breaker, and six finishing mills with a delivery speed of 1620 feet per minute. Each mill lengthens the steel and reduces its thickness. The last finishing mill discharges the steel — now in strip form — on the run-out table where it is cooled by five banks of water sprays as it is conveyed 258 feet to the first reel which winds it into a coil. Twenty-four feet beyond the first reel is the second reel. The reels work alternately, the first being unloaded while the second is coiling the strip coming off the mill.

The coils are unloaded on a conveyor system that is the only one of its kind in the steel industry. Built under the floor levels of the hot mill building and the adjacent pickler building, the conveyor consists of small flat cars that are coupled together on an endless oval track. Operated by electrical controls, the conveyor brings empty cars into position before the hot mill reels, receives a coil, then moves forward. On the opposite side of the conveyor, under the pickler building, a coil is unloaded each time the conveyor stops.

The coils are raised to floor level in the pickling building to be started through the many finishing processes by which hot strip steel is made into tin plate or various types of steel sheets.

UNITED BUILDS LARGEST STEEL MACHINERY CASTING

▲ The United Engineering and Foundry Company has just completed what is reputedly the world's largest steel machinery casting. It weighs 472,000 pounds. Made for the Ajax Manufacturing Company, it is to be used as a frame for a 6000 ton capacity, high-speed, mechanical forging press.

The pattern for the huge casting, made by the Eclipse Pattern Company, required over 30,000 feet, or almost a full carload of lumber; 500 pounds of nails and 10 gallons of lacquer. More than 2500 man-hours of labor were required to build it.

Over 1,250,000 pounds of specially prepared molding sand was required for the mold and 3600 man-hours were spent on this operation. The mold was formed in a pouring pit 18 feet wide, 39 feet long and 16 feet deep — large enough to hold a small house.

After the pattern was removed and the cores set, hot air was circulated for seven days through the mold to remove all traces of moisture.

Four open hearth furnaces poured molten steel simultaneously into four ladles, which in turn were carried to the pit by overhead cranes. The 600,000 pound main pouring was accomplished in four and one-third minutes, after which 100,000 pounds of additional molten metal was poured at several intervals to make up for shrinkage.

The casting was next allowed to cool in sand for two months. Another month was spent in removing cores, heads, gates and risers, and in cleaning the casting surfaces.

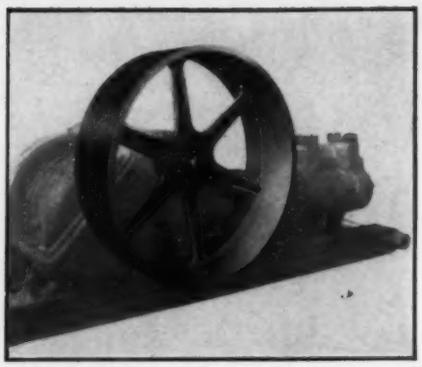
A special 90-foot freight car with 12 wheels at each end was required to carry the heavy casting (the conventional car is a little over half as long and has four wheels at either end). As the total weight of the casting, car and blocking was over 800,000 pounds, a special train was made up to transport the unusual cargo. It consisted of an engine, three empty flat cars and the loaded car — the three empty car lengths separating the engine and cargo so both would never be on a bridge at the same time. Movement of the train was also restricted. It could go no faster than ten miles per hour and then only by daylight.

—2-E-1—

A special freight car and train were required to transport this heavy casting.

NEW SHEAVES FEATURE IMPROVED GROOVE-BELT FIT

▲ The new lines of QD sheaves, featuring improved groove-belt fit and reinforced arm construction, have been announced by Worthington Pump and Machinery Corporation. Designated as the A and B lines, each will feature individual groove size to match belt size — thus an A groove for an A belt, a B groove for a B belt. Former A-B combinations have been discontinued.



The reinforced arm construction of the new sheaves incorporates a longitudinally ribbed arm recessed down the middle.

Like the "I" beam construction of a bridge girder the reinforced arm construction of the new QD driven sheave incorporates a longitudinally ribbed arm recessed down the middle. Advantage of this type of arm is that material is removed at or near the neutral axis where it adds little or no strength to the arm. This material is then added at the points most remote from the neutral axis where it gives the greatest strength.

—2-E-2—

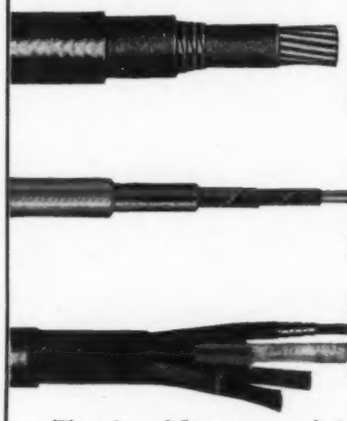
BABCOCK AND WILCOX TO CENTRALIZE RESEARCH

▲ The Babcock and Wilcox Company, announced a program of expanded research in a building on a 20-acre site purchased by it near Alliance, Ohio. All the research activities of the Babcock and Wilcox Company, now carried on at its plants, eventually will be centered in the new research development.

With the building, the company has purchased 20.28 acres of land.

Fields to be covered in the research program will include generation of steam, combustion methods, utilization of fuels, metallurgy and welding, refractories, and other fields closely connected with the company's extensive manufacturing program. Work will start immediately on refitting the purchased building for use as a

The Electrical Maintenance Man KNOWS!



FOR POWER CIRCUITS

ROCKBESTOS A.V.C. 600 VOLT
POWER CABLE — TYPE AVA
(Flexible stranding for motor leads)
Maximum operating temperature 110°C.

FOR LIGHTING CIRCUITS

ROCKBESTOS A.V.C. 600 VOLT
BOILER ROOM WIRE — TYPE AVA
Maximum operating temperature 110°C.

FOR CONTROL CIRCUITS

ROCKBESTOS A.V.C. 600 VOLT
MULTI-CONDUCTOR CONTROL CABLE

Three of 123 different permanently insulated wires and cables designed by Rockbestos for severe or unusual operating conditions.

Few electrical maintenance men who have worked around hot-spot installations very long have to be told which cable can really take it. Once they've seen Rockbestos A.V.C. in troublesome locations they know that it stands up where other types fail and greatly reduces the need for frequent and expensive re-wiring.

The reason Rockbestos A.V.C. wires and cables operate so dependably under unusually severe conditions lies in their *permanent insulation* of impregnated asbestos. They won't bake brittle, crack or flow even at operating temperatures ranging up to 230°F. And they won't deteriorate with age nor rot when exposed to oil, grease or corrosive fumes.

Rockbestos A.V.C. constructions in 600 to 5000 volt ratings include single and multi-conductor power cables, switchboard and lighting wires, control cables and other National Electrical Code types. Write for a catalog, recommendations or samples.

ROCKBESTOS PRODUCTS CORPORATION
176 Nicoll St., New Haven 4, Conn.

ROCKBESTOS A.V.C.
The Wire with Permanent Insulation

NEW YORK ST. LOUIS BUFFALO LOS ANGELES CLEVELAND SAN FRANCISCO DETROIT CHICAGO PORTLAND, ORE. PITTSBURGH SEATTLE

laboratory. It is expected that some research projects will get under way there within a few weeks.

U. S. STEEL WILL SPEND $34,000,000 ON MESABI

▲ A $34,000,000, six-year program permitting use of lower-grade iron ore on the Mesabi range has been launched by the Oliver Mining Company, a subsidiary of the United States Steel Corporation. The program will also permit reclamation of fine ores, now being lost in tailings, and in addition an elaborate research program. Two beneficiating plants costing $2,000,000 will be constructed by United States Steel. Four additional plants are scheduled for later construction. Beneficiation is taking unwanted materials out of the ore after it is dug. The high ore content of the minings over a long period of years permitted direct shipping. In the program of using marginal and high silica ores, much extraneous material will be mined and more labor and more machinery will be required to get rid of it.

The product to be discarded is silica. The new program calls for the erection of plants which will use heavy-media separation. This is a version of "sink and float" considered to be better than more washing. United States Steel has been washing and cleaning in Minnesota since 1910, but some fine ores are lost in the process. These fines now will be concentrated in agglomeration plants, from which the product may come out as sinter, nodules or briquettes. The extent to which beneficiation will prolong the life of the Great Lakes ore region is uncertain, but it may be for generations.

BIG FELLOWS
FOR BIG JOBS
The Blaw-Knox line of Heavy-Duty Four-Rope Buckets includes specialized designs for fast rehandling of coal, ballast, ore and barge clean-up. Capacities from 4 to 25 tons. There is an array of buckets listed and illustrated in Blaw-Knox Catalog No. 2059 which covers every conceivable bucket need — including yours. Send for a copy.
BLAW-KNOX BUCKETS
BLAW-KNOX DIVISION OF BLAW-KNOX COMPANY
2040 Farmers Bank Bldg.,
Pittsburgh 22, Pa.

OPEN HEARTH SAFETY

By E. T. CROKER
Superintendent, Open Hearths,
Continental Foundry and Machine Company
East Chicago, Indiana

▲ Everyone knows, but few people realize, how dangerous a reckless worker can become, and it is not always the reckless person who is the one injured. Too often the innocent bystander, through no fault of his own, is the victim.

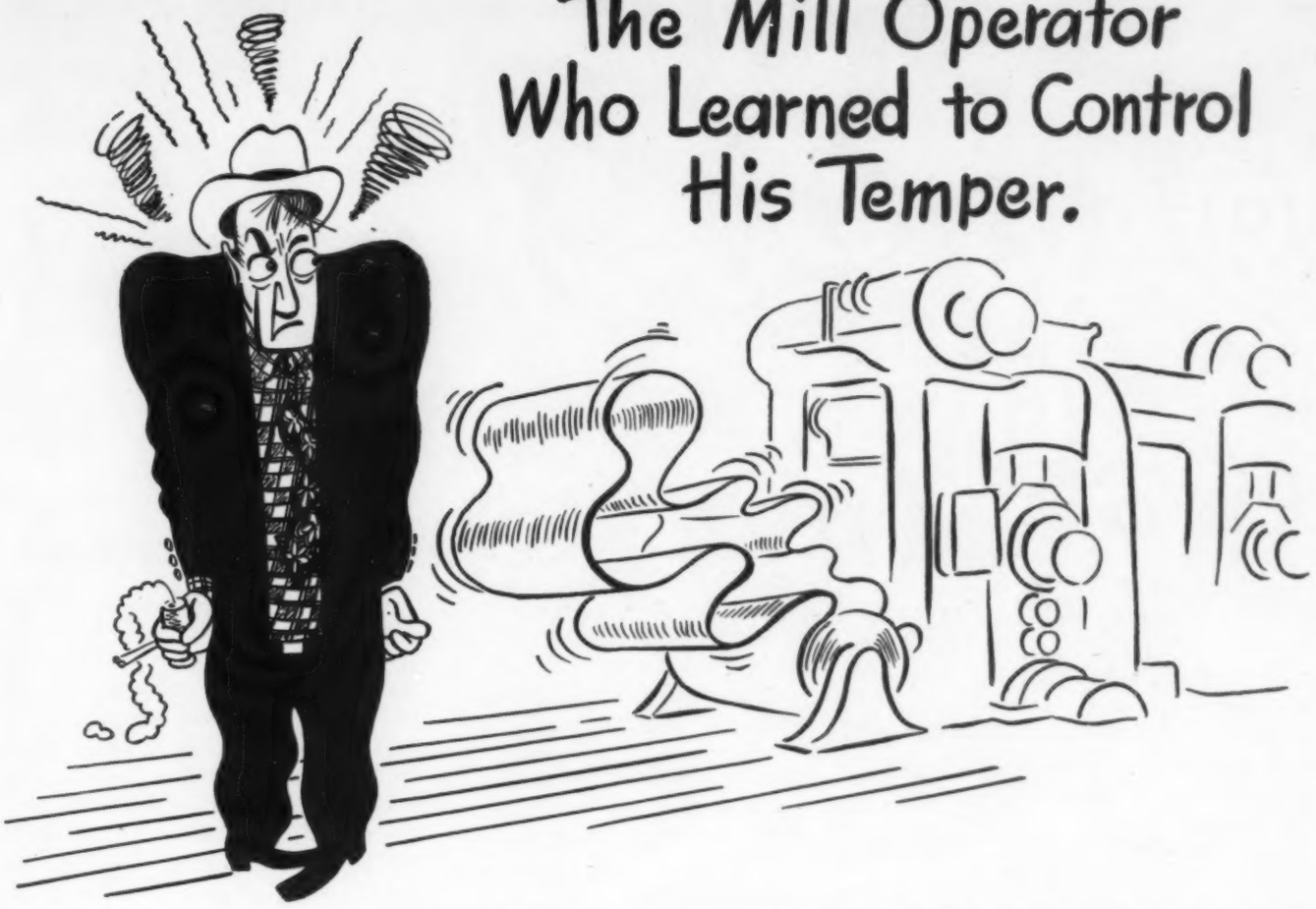
It has been over 10 years since a lost time accident has happened in the open hearth department of our plant, and I feel proud of the record that the men in my department have made, for without the united effort of every man in the organization, this record could never have been accomplished.

Safety is not a part-time job. Your plant has to be as safe when working part-time as when operating at full capacity. It must be as safe for the new employee as for the man who has been on the job for many years.

When hiring a new man, we instruct him relative to the danger of the work. We place him with our safety man, who teaches him to work safely. We believe that all tools on the open hearth platform are hot and test them before using to make sure they can be handled without injury. We have burns from splashing metal the same as all plants do with similar operations.

Our material is piled out in the weather and, during the wet or cold

The Mill Operator Who Learned to Control His Temper.



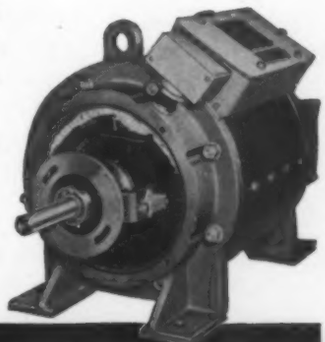
FEW THINGS ARE HARDER on the temper of a steel mill operator than time lost due to a "cobble" while rolling steel. And similarly, nothing is so hard on the temper of *steel* as rolling under *uneven tension.*

A wise operator learned to control both his own temper and that of his steel by installing accurate "Regulex" control on his temper mill. Through close control of strip tension during all the stages of reel build-up, from stand-still . . . to top speed . . . to deceleration, "Regulex" control helped him produce tempered steel of superior quality, as well as a compact, evenly-wound coil.

Moreover, the operator found that when he replaced old-type equipment with high speed "Regulex" control, he actually *doubled* the daily capacity of his mill!

MORAL: Modern "Regulex" control has wide application in steel plants . . . wherever rapid adjustments are needed in torque, tension, speed, current, or any other variable which can be measured electrically. By its fast response, without overshooting, it helps increase production, save money, protect machines. "Regulex" control systems involve fewer contactors, no trick circuits . . . machines themselves are simple and rugged.

For the full story on "Regulex" control, see our nearby sales office, or write ALLIS-CHALMERS, MILWAUKEE 1, WISCONSIN. A 2078



ALLIS AC CHALMERS **REGULEX CONTROL** *"The Educated Generator"*

seasons it becomes covered with ice and snow, and there is danger of explosion when charging the furnace with this type of material. We try to keep it inside and dry with a gas flame to reduce this hazard to a minimum. We also try to keep our tools piled in an orderly manner, to minimize the hazard of tripping, as good housekeeping has paid dividends.

We never have an oxygen hose with a valve attached to burn out a tap hole except at the station where hose is connected. We believe that a hose up-to-pressure, lying on the floor, might come in contact with some hot tools, causing someone to be burned.

Our men know that protective clothing keeps out heat and protects them from burns. No one is allowed to tap a heat without a long sleeve shirt.

Everyone is taught to stay away from the furnace at the time it is reversed, as the pressure set up may cause a person to be burned if standing too closely to peep holes. At the time of working on tap holes, no reversing of the furnace is allowed, without first notifying the men at work that this is going to be done, so everyone is in the clear. Safety shoes are also a must in our department.

No suggestion is overlooked when made by any employee in the department and, if his idea is used, due credit is given to the one making same.

Any employee who receives the slightest burn or minor injury must report to the hospital for immediate treatment to eliminate the possibility of infection.

Salt tablets are placed at drinking fountains to relieve fatigue. Heat cramps are almost unheard of since these dispensers have been installed.

Safety in the open hearth department is no different than in any other department, on the street, or in the home. When the young fellow comes into industry with a good background of safety in his home, he should make a safe worker.

I recall just a short time ago, that while waiting for a train to pass (the crossing was protected by safety gates), I saw a lady with four children lift up the safety gate and walk upon the tracks with her children. While standing in that dangerous place waiting for the train to pass, another train came from the opposite direction, traveling on the tracks where they were standing. When she saw the other train, instead of getting out of danger, she gathered the children around her like a hen with a brood of little chicks, and stood between the two trains until they passed.

Fortunately no one was hurt, but what type of employee is coming into industry with such safety teaching as this? No doubt, these children think like all children do, that what their mother does is right.

We, in our department, do not take chances. We try to do all jobs the safe way. We look for the hazards and try to correct them, using the human way in teaching our fellow workers to work safely. We do know that by being eternally vigilant, we can have a safe department!

PENNSYLVANIA TRANSFORMER SHIPS FROM NEW PLANT

Twelve 1000 kva power transformers mounted for shipment on three flat cars, move out of Pennsylvania Transformer Company's new factory. These were the first transformers to be shipped from the plant, which Pennsylvania recently took over. The factory is located in Canonsburg, Pennsylvania. **——2-E-3——**

STEEL MILL ENGINEERING FIRM CHANGES ITS NAME

▲ The Pennsylvania Engineering Works, builders of blast furnace and steel mill equipment, incorporated in 1899, was recently merged into the Pennsylvania Engineering Corporation. All of the former Pennsylvania Engineering Works' assets, liabilities, contracts, agreements, etc., have been merged into and absorbed by the Pennsylvania Engineering Corporation, the surviving corporation.

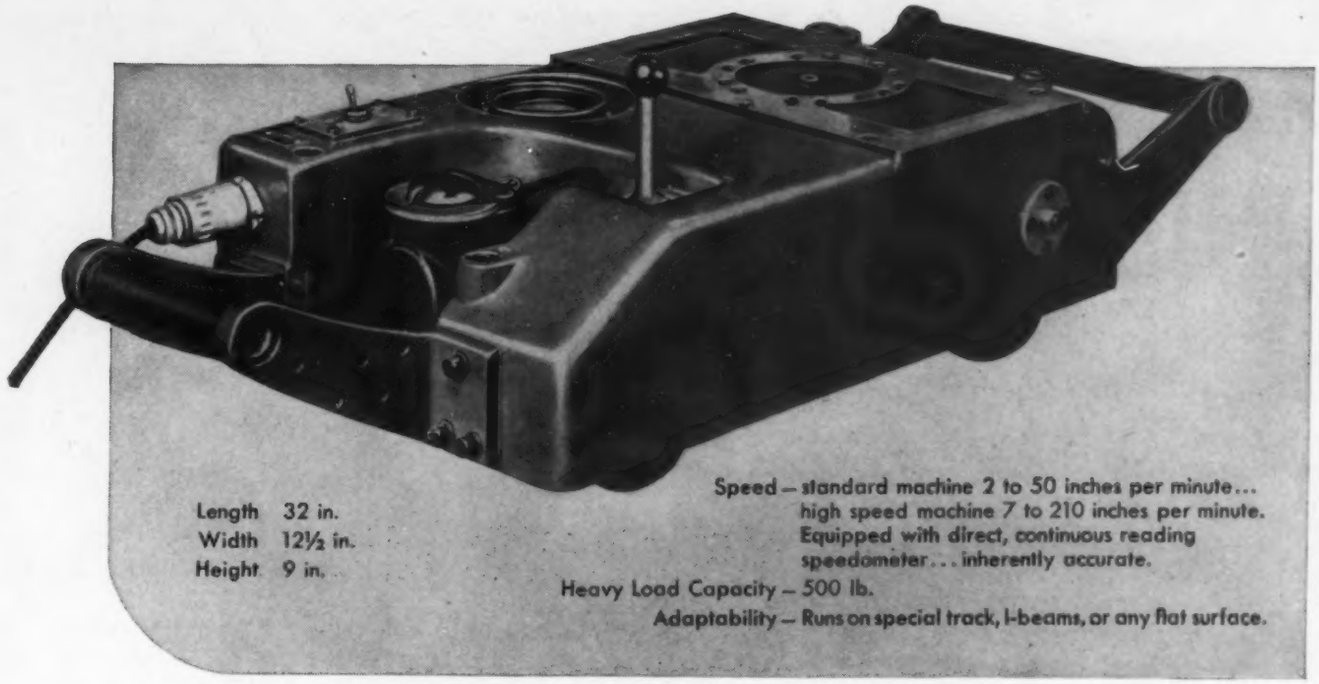
There has been no change in the business formerly conducted by the Pennsylvania Engineering Works and the officers, directors, and personnel of the Pennsylvania Engineering Corporation are the same as those of the former Pennsylvania Engineering Works.

WESTINGHOUSE DEVELOPS LARGER DE-ION GRID

▲ Power systems have expanded in size and more interconnections have been made between systems. As a result the interrupting duty on high-voltage power circuit breakers exceeds the ratings available a few years back. This has led to the development in the Westinghouse laboratory of larger grids for oil breakers and interrupters for air breakers. The new de-ion grid, termed the "Multiflow," can interrupt three and one-half million kva. Two and one-half million was the previous top limit. It is expected that soon a multiflow grid will have been tested at five million or better. And that is no final limit.

This type of de-ion grid differs from the older forms in that extinction is accomplished by forcing several jets of oil under pressure across the lengthening arc. This differs from the previous method for high-voltage interruption in which the arc is pulled magnetically into the oil. The result is faster arc interruption, and also a much smaller gas bubble. Because of this latter it has been possible to reduce the physical size of the circuit breaker tanks by as much as 50 per cent. This resulted in a much smaller consumption of steel and insulating oil when both were critically short. There is also, of course, the added advantage of less space requirements in the switchyard and simplification of provisions for handling and purifying oil.

These same power-system changes during the emergency period required



Length 32 in.
Width 12½ in.
Height 9 in.

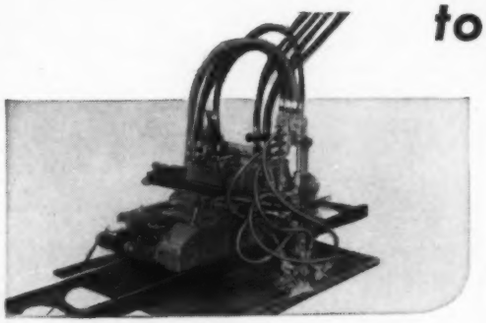
Speed – standard machine 2 to 50 inches per minute... high speed machine 7 to 210 inches per minute. Equipped with direct, continuous reading speedometer... inherently accurate.

Heavy Load Capacity – 500 lb.

Adaptability – Runs on special track, I-beams, or any flat surface.

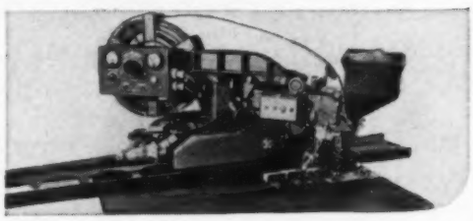
An Electric "PACK MULE"

to mechanize these processes



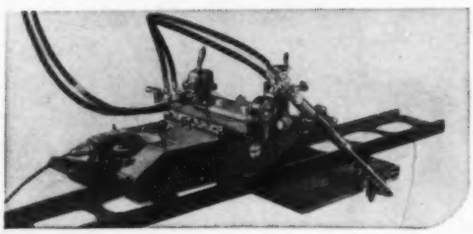
CUTTING

Straight Line Cutting
Bevel-Cutting
Heavy Duty Cutting
Plate-Edge Preparation



WELDING

UNIONMELT Automatic Electric Welding
HELIARC Welding
Mechanized Oxy-Acetylene Welding



HEAT TREATING

Flame-Hardening
Flame-Softening
Flame-Strengthening
Stress-Relieving

Ask Linde for more information

The words "Unionmelt," and "Heliarc" are trade-marks of Union Carbide and Carbon Corporation or its Units.

THE NEW CM-37 MACHINE CARRIAGE

THE LINDE AIR PRODUCTS COMPANY
Unit of Union Carbide and Carbon Corporation
30 E 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities
In Canada: Dominion Oxygen Company, Limited, Toronto

also that the interrupting time be speeded up. Changes in design have made available five-cycle breakers in the higher voltage classes where eight or twelve-cycle interrupting was acceptable not many years ago.

The performance of the new grid as demonstrated in the laboratory shows that these breakers can be used for fast reclosing times of twenty cycles or better. Automatic reclosing on high-voltage transmission lines is increasing in popularity and as many as one third of the breakers now being installed are provided with mechanisms suitable for fast reclosing.

The extent to which compressed air breakers will be used for high-voltage outdoor applications is still an open question. In their favor is the ever-present desire to eliminate oil. However, tests indicate that other hazards are introduced. All designs considered thus far have limitations in the manufacturing cost, because it is difficult to install current transformers and potential devices in this breaker as easily as with a conventional dead-tank breaker. Other factors are mechanism complication, insulation, and weather proofing. Space limitations also make this apparatus less desirable, and in many cases may be a deciding factor. Experience shows the oil hazard to be negligible especially with the smaller quantities used in the new breakers. Further, the difficulty of securing strength and rigidity with a structure composed largely of porcelain, makes it all the more difficult to produce a compressed-air breaker competitive with oil circuit breakers. The issue is not settled, however. Experimental compressed-air outdoor units are continuing in operation, one for 138 kv having been in use four years.

Design work has been underway leading toward the production of apparatus for voltages above 287 kv, the present maximum operating voltage. Power systems in the United States and also other countries will soon require apparatus with a voltage rating of the order of 400 kv. Recent studies have proven that this is quite feasible without fundamental changes in interrupter design. Applications of this higher voltage apparatus are likely within the next few years.

—2-E-4—

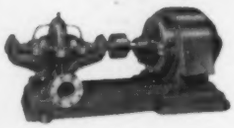
PEERLESS PUMPS

PEERLESS

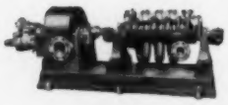
(FORMERLY DAYTON-DOWD)

CENTRIFUGAL PUMPS

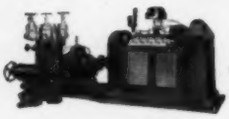
Built for Regular or Special Pumping Applications where Temperatures and Pressures are Variable, and Normal, Dense or Viscous Liquids are to be Handled. Types illustrated represent a few of scores of Peerless Centrifugal Pumps for industrial application.



Type A
CENTRIFUGAL PUMPS
For General Services.
Capacities:
Up to 60,000 g. p. m.

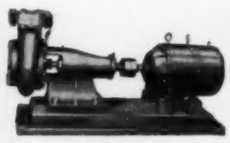


Type B
CENTRIFUGAL PUMPS
For Boiler Feed, Refinery and Pipe Line Service.
Pressures to 7001bs.



Type AF FIRE PUMPS
(Formerly Dayton-Dowd)
Underwriters Approved.
Capacities:
Up to 2,000 g. p. m.

Type XT
(VANE) PUMPS
For Butane-Propane, Processing and General Service.
Capacities:
Up to 150 g.p.m.



Type DS
CENTRIFUGAL PUMPS
For Chemical, Oil, Food Processes, etc. Capacities:
Up to 600 g.p.m.

PEERLESS UTILIZES ADVANCED PRINCIPLES OF HYDRO-DYNAMICS

Peerless Horizontal Centrifugal Pumps (formerly Dayton-Dowd) are available in sizes, pressures and capacities for practically all pumping services. They are being used to most efficiently serve applications in all industries where continuous, heavy duty pump performance is required affording long-lived, trouble-free service with a minimum of maintenance.

Contact or write your nearest Peerless distributor for engineering data and full details of Peerless Centrifugal Pump advantages.

PEERLESS PUMP DIVISION

FOOD MACHINERY CORPORATION

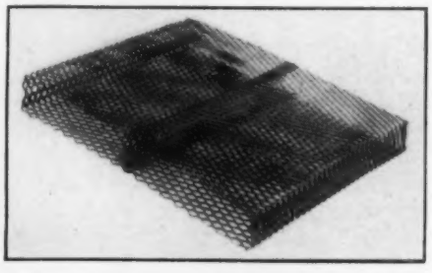
Factories: 301 W. Avenue 26, Los Angeles 31, Calif.; Quincy, Illinois; Canton 6, Ohio

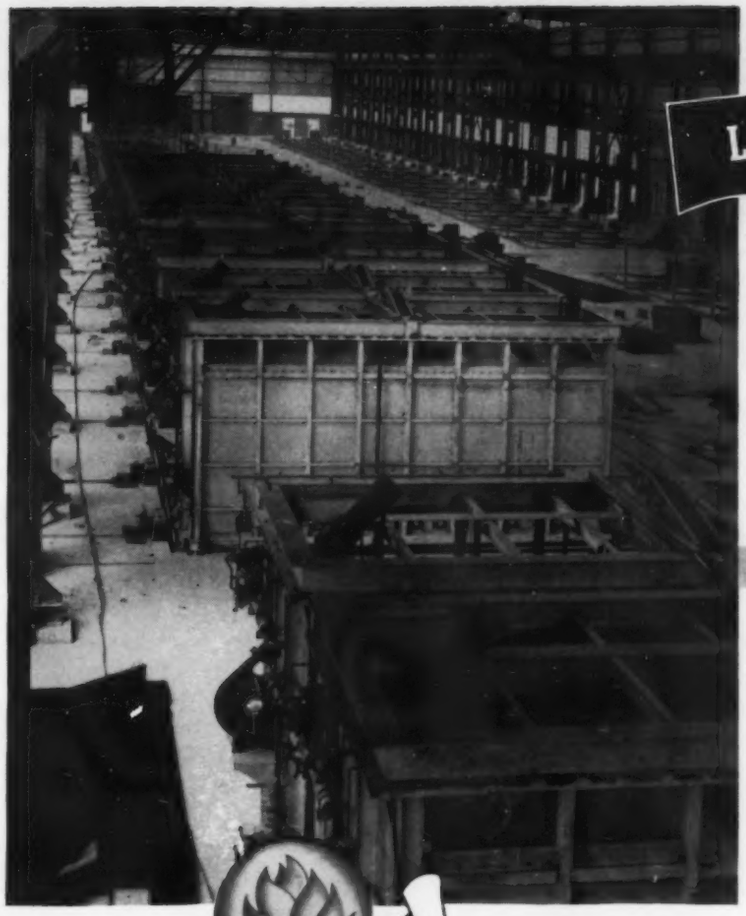
METAL LOADING PALLET ACCOMMODATES 3000 LB

▲ A new expanded metal loading pallet, which combines light weight with tough serviceability, has been designed by Phillips Mine and Mill Supply Company.

The expanded metal process provides a lightweight pallet with sufficient desk friction to effectively hold loads. The new pallet is constructed of 13 gauge material with ½ in.

This expanded metal loading pallet will accommodate 3000 lb of load.





LATEST DEVELOPMENTS IN FURNACE *Design*

These furnaces for annealing strip were installed in a new strip mill at a large eastern steel plant. They are direct fired and represent the latest developments in the art of furnace design.

The results are

- **Greater production than with other types of furnaces**
- **Absolute uniformity for metallurgical requirements**
- **Important reductions in fuel used per ton**
- **Easier to operate and handle**

Further details upon request by letter, telegraph or telephone. No obligation.

FURNACE BASES

FURNACE INTERIOR

F.E.I.

F. E. I. EQUIPMENT

Direct-Fired Cover Furnaces for annealing, spheroidizing, Normalizing and Bright annealing of wire, rods, coiled strip, flat sheets and tin plate.

For Heavy Coil Loads: Patented Convection Base, gives 2 to 4 times longer service.

For Wire, Bar and Tube Mills: Galvanizing, Patenting and Normalizing Furnaces.

For Pipe, Sheet, and Job Plants: Hot Dip Galvanizing Furnaces.

Car Type Furnaces, Rod Heating, Lead Quenching, Ladle Heating and Salt Bath Descaling Furnaces.

Continuous Quenching and Tempering Furnaces—Quench Tanks, Water or Oil.

Soaking Pits

FURNACE ENGINEERS, *Inc.*

Specializing in the design, manufacture and installation of furnaces for the metal working industries

1551 WEST LIBERTY AVENUE ★ PITTSBURGH, PA.

WHEN MOTORS MUST BEAT THE HEAT...

SOME MOTORS JUST CAN'T ESCAPE CONDITIONS LIKE THIS. But there *is* a way for you to escape shutdowns due to motor burnouts. Make sure that the motor is wound with Deltabeston* magnet wire.

Deltabeston, the outstanding Class B insulated magnet wire, is the choice of leading motor makers. Used to rewind motors, it gives protection from high ambient temperatures, and adds to motor life where overloading is unavoidable.

The Deltabeston line of magnet wires includes both asbestos-insulated and glass-insulated types, round, square, and rectangular, in a full range of sizes. It is the product of top-rank experience in heat-resistant wire. Our engineers can give you practical, point-of-use advice on the right wire for any combination of operating conditions. Just tell your motor-repair people: "Rewind it with Deltabeston." Write for information to Section Y51-246, Appliance and Merchandise Department, General Electric Company, Bridgeport 2, Connecticut.

DELTABESTON MAGNET WIRE

**Trade-mark Reg. U.S. Pat. Off.*

GENERAL ELECTRIC

openings and will accommodate approximately 3000 lb of load, regardless of size.

A new wood deck steel-bound pallet has been added to their pallet line in response to numerous requests for such a product. Both of the new pallets are now available to industrial users.

—2-E-5—

SLAB HEATING FURNACE FOR ALLEGHENY LUDLUM

▲ A continuous slab heating furnace to heat steel alloy billets prior to rolling will be built for Allegheny Ludlum Steel Corporation at Brackenridge, Pennsylvania, by the Rust Furnace Company.

The furnace, rated at 35 tons per hour of high-grade alloy, will be triple fired, zone controlled, end charged, end discharged and non-recuperative. Contract price is in excess of $160,000.

—2-E-6—

KAISER PLANT EXPANSION IS NEARING COMPLETION

▲ Kaiser Company's steel plant at Fontana, California has reached the halfway mark in its $11,500,000 expansion program. The plant will bring to the west coast such improvements as the only pipe mill west of the Mississippi, a cold rolling mill for light-gauge strip steel products, equipment for the manufacture of cold drawn bars, and alterations in the present structural and merchant mills to make a new and wider range of products. New facilities also include a finished steel warehouse, and additional utilities and supplementary services required for the increased operation.

These new facilities will turn out an annual production of approximately 125,000 tons of pipe, 42,000 tons of cold rolled strip steel and 24,000 tons of cold drawn bars.

When the conversion program has been completed, Kaiser Steel's payroll of 3,500 employees — who receive some nine and one-half million dollars annually — will reach 4000.

Despite material shortages, Kaiser Steel's first full year of peacetime

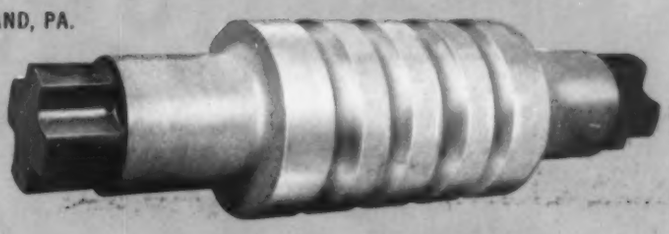
(*Please turn to page 119*)

1913 *we developed the first water-cooled process for solidifying heavy bodies of rolls*

So what? In the development of Red Wabbler Rolls many special processes have been pioneered, improved, perfected—and then replaced as the need arose for better mill rolls, and better roll manufacturing methods. But these continuing developments were only possible because of your cooperation as experienced mill operators. Your own demands for greater rolling-mill production, better surface finishes, longer roll life, have been fulfilled by Red Wabbler Rolls because your training has supplied the practical metal-rolling know-how on which Mackintosh-Hemphill engineers and metallurgists base their research. In 1913, or 1923, or 1947—in any year and in every year—the success of metal-rolling operations depends on the skill of the operator and the knowledge and facilities of the roll manufacturer. In the combination of your own rolling-mill experience and Mackintosh-Hemphill roll engineering and manufacturing facilities there's a real productioneering team.

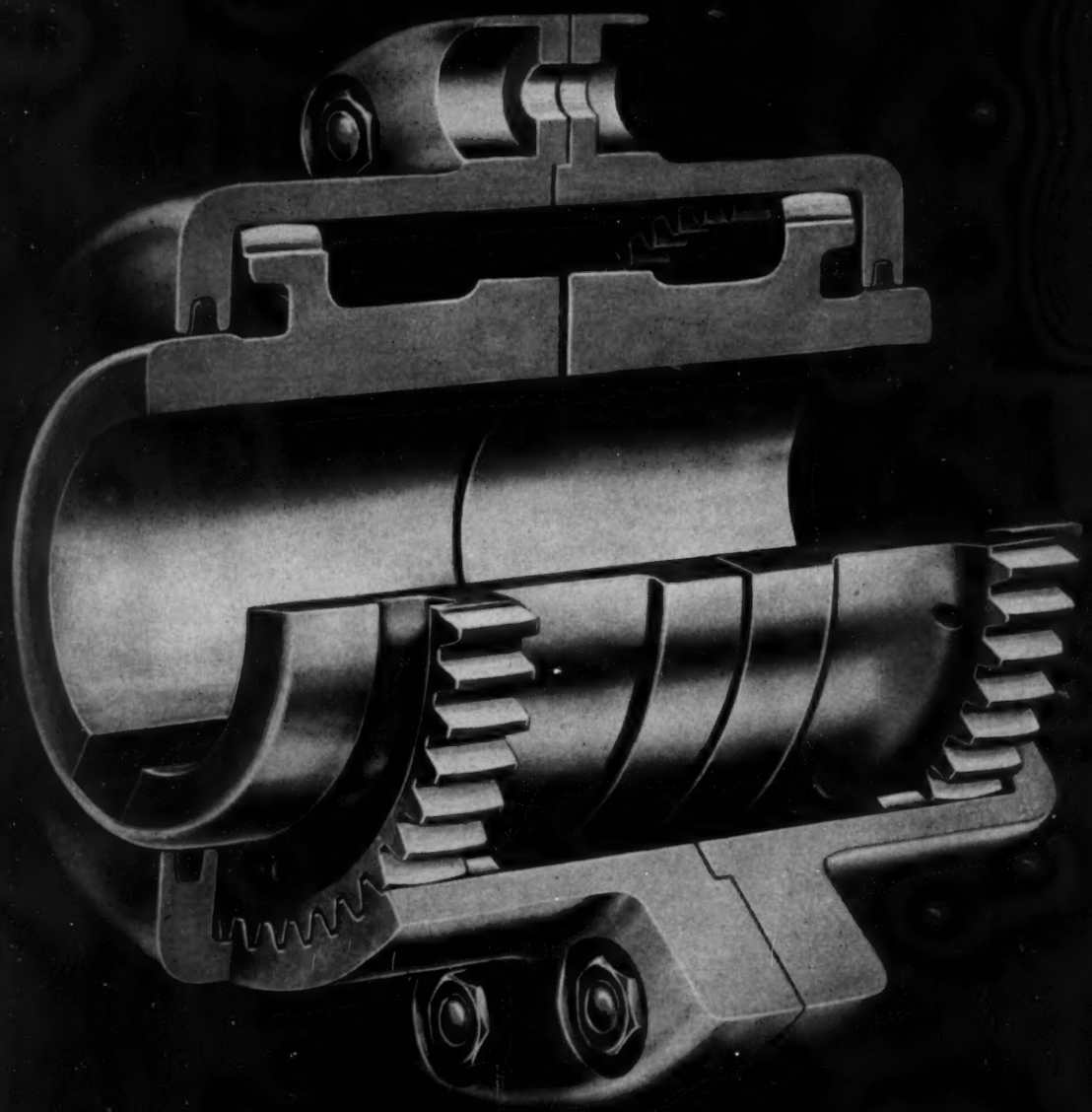
MACKINTOSH-HEMPHILL CO.

PITTSBURGH and MIDLAND, PA.



Makers of the rolls with the red wabblers

POOLE



A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

(*Continued from page 116*)

operations was closed with a total of more than 350,000 tons of steel produced and delivered to fabricators in 1946.

Kaiser Steel's installation of a Fretz-Moon pipe mill is of particular significance to the west. The new mill, largest single improvement, will produce standard butt-weld pipe from one-half inch to four inches in diameter and which is critically needed for western home building at the present time.

Addition of cold rolling mill at Fontana will provide manufacturers with lightweight strip products for manifold use in the war-born steel consuming industries of the west. The mill will produce strip from 16 to 31 gauge to a maximum width of 18 inches. Such products are used to manufacture desk lamps, bathroom cabinets, calculating machines, flashlights, oil cans, auto parts and hundreds of other similar articles.

The new cold drawing facilities for finished steel bars will produce rounds up to 4½ inches in diameter and a variety of other shapes like flats, hexagons and squares. Such products are in demand by machine shops and manufacturers of shafting, screws, bolts, etc.

Alterations converting the 36-inch breakdown mill into a 40-inch blooming mill were completed on September 3, 1946. A major portion of this work, which normally would have taken a month, was rushed to completion in seven days so that lost operating time would be at a minimum.

As the new year started foundations had been laid for the annealing furnaces and other equipment in the cold rolling mill. Fuel oil tanks, the stack and foundations for the skelp furnace in the pipe mill have been completed. Cold drawing equipment will be installed in the present alloy finishing building, where eight-inch shells for the war effort were previously produced.

Another integral plant improvement now underway is development of historic Eagle Mountain in Riverside County, California, as a source for ore. The iron and steel division of Kaiser Company, Inc. recently purchased the large ore deposit which is excellently situated some 130 miles from Fontana.

AMERICAN BRIDGE BUILDS WORLD'S LARGEST CRANE

World's largest overhead traveling crane, capable of lifting battleship gun turrets and other huge sections weighing as much as a million pounds, is shown being erected by U. S. Steel's American Bridge Company in the San Francisco naval shipyard at Hunter's Point, California. Twin cranes will operate singly or in tandem atop a bridge type runway 207 feet high. The 730-foot runway spans a pier 405 feet wide, extending 162½ feet over the water on each side. A total of 8400 tons of steel went into the runway structure and cranes.

No other one instrument

PERFORMS ALL THESE FUNCTIONS

INDICATE AIRFLOW

INDICATE FUEL FLOW

SHOW RATIO OF AIRFLOW and FUEL FLOW

The Hays Visio-Ratio Gage is unique among indicating instruments because it performs the functions of three indicators—air-flow, fuel-flow and ratio.

Illustrated is a Visio-Ratio Gage which measures the flow of gas to a gas fired industrial furnace and the flow of air used for the combustion of the gas. Both these scales are calibrated in rate of flow in 1000 cu. ft. per hour.

The center scale is calibrated to show the percentage of excess of deficiency of air used to burn the gas with a range of 30% deficiency to 50% excess.

The spot at which the pointers cross over the center scale indicates directly the percentage of excess of deficiency of air used for combustion, eliminating the mathematical calculations which otherwise would be required with each change in flow of gas or air. The ratio used depends on the type of flame desired—oxidizing or reducting.

The HAYS CORPORATION
SINCE 1907
COMBUSTION INSTRUMENTS AND CONTROL
MICHIGAN CITY, INDIANA U.S.A.

GOODYEAR PICKLER ROLL RESISTS CUT DAMAGE

▲ Almost complete resistance to damage from cuts is promised in a new roll for steel mill pickling lines developed by Goodyear Tire and Rubber Company.

This roll utilizes an inner cover of especially-developed fibrous material which guards the steel core from contact with acid.

Known as the special hold-down and carrying roll, the new roll continues to utilize a high grade synthetic rubber cover on the weight-carrying surface. This outer cover is unaffected by acids.

Until development of the new fibrous material, which is bonded by a special process to the steel core, cuts in the rubber surfaces of pickling tank rolls often permitted acid to reach the core and destroy it.

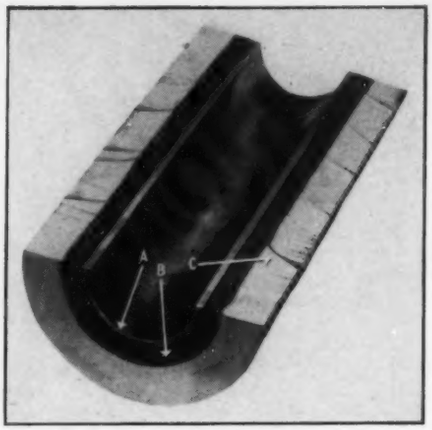
This fibrous material is sufficiently hard to absorb the shock of practically all cuts to which pickling tank rolls are subjected, while remaining immune itself to damage from acid seeping through the gash.

The roll's synthetic rubber surface is bonded in turn to the fibrous material. A newly-developed bonding process assures tight adhesion of the fibrous material to the roll core and cover for the roll's life.

In the pickling process, these rolls are used to carry sheet steel through baths of sulphuric or other acids to remove scales from the steel before further rolling.

Regardless of the diameter of each of the new type rolls,

Acid seeped through gashed rubber cover severed the steel core in this old type steel mill hold-down roll.



Cross-sectional closeup of new hold-down roll reveals these components: A — steel core of roll; B — especially developed fibrous inner cover which armors core against acid penetration; C — test cuts inflicted on outer rubber surface failed to pierce secondary fibrous cover.

GAMLENITE is a unique dry powder that is blown into the furnace while it is operating. It reduces corrosive combustion deposits and hard slag to a fluffy powder, which is normally carried out the stack by the draft.

Gamlenite reaches spots inaccessible to hand cleaning, which it practically eliminates. It assures efficient heat transfer, lengthens life of tubes* and refractories, keeps boilers on the line. It is safe, non-explosive, can be used in all types of boilers. Send for Bulletin 454.

*Gamlenizing boiler metal surfaces makes them corrosion-proof, protecting against destructive action of acids in the combustion deposit, and greatly reducing the adherence of future deposit. Only Gamlenite has this feature.

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YES,
YOU CAN GET
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CASTING QUALITY
AND PROMPT DELIVERY
ON THE KINNEY
REFRACTORY LINED TUYERE COOLER

● Falcon's specialized non-ferrous service to the Steel Industry includes licensed production of this advanced design in tuyere coolers. The refractory, which may be brick or quick setting cement, protects the tuyere cooler from hot metal which may cut back through the tuyere and blow-pipe. Covered by Patent Application Serial No. 530153.

● High Grade Copper Cooling Castings for Blast Furnace Requirements.
● Standard and Special Tuyeres.
● Bronze Bearings of any type but specializing in Steel Mill Rolling Bearings.
● Electrodes used in production of electrically welded pipe or tubing.
● Copper Welding Rolls. U. S. Patent No. 1,973,680.

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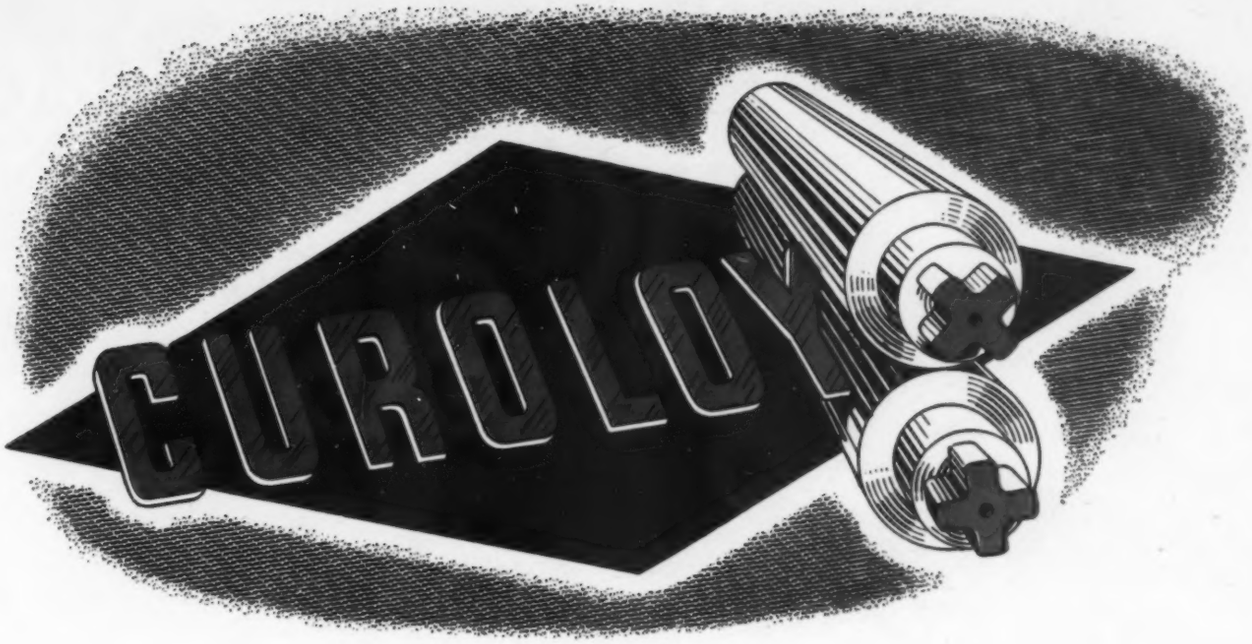
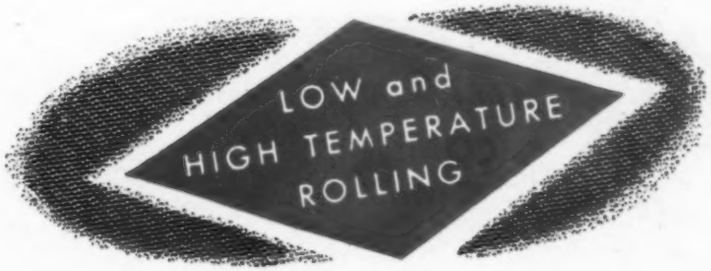


The Birdsboro patented grain roll for Roughing, Semi-Finishing and Finishing of mild, alloy, tool and special steels; non-corrosive irons and steels; non-ferrous metal bars and shapes at



Type Rolls (Pat.)

Birdsboro "30"
Birdsboro "40"
Birdsboro Metal
Curoloy
Grainloy
Superloy
Bronze Wobbler

Available in four grades—Hard, Medium, Mild and Extra Mild to meet your specific requirements. If it's a roll problem, consult Birdsboro.

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Manufacturers of Steel Mill Equipment, Iron and Steel Rolls, Hydraulic Presses, Crushing Machinery, and Special Machinery

fibrous material is applied to each core in a quarter-inch layer. Similarly, the rubber weight-carrying surfaces of the rolls will remain about three-quarters of an inch.

Since the new-type roll is armored against acid penetration, life of the core is virtually unlimited and full service of the original rubber surface is gained before recovering is necessary.

—2-E-8—

ARMCO'S BUTLER PLANT IS SPENDING $10,000,000

▲ A $10,000,000 expansion program is underway at the American Rolling Mill Company plant at Butler, Pennsylvania, which will include construction of a new electric melting furnace, a new slab mill, a grinding and scarfing building, and the installation of new equipment. The new facilities will probably be completed in 1948.

The Armco plant at Butler employs 3750 workers and produces specialty steel sheets. In addition, forged steel wheels for railroad and industrial uses are manufactured.

During a year's time, the Butler division uses 270,000 tons of scrap, 175,000 tons of pig iron, 33,000 tons of limestone and 8,000 tons of iron ore in the manufacture of steel.

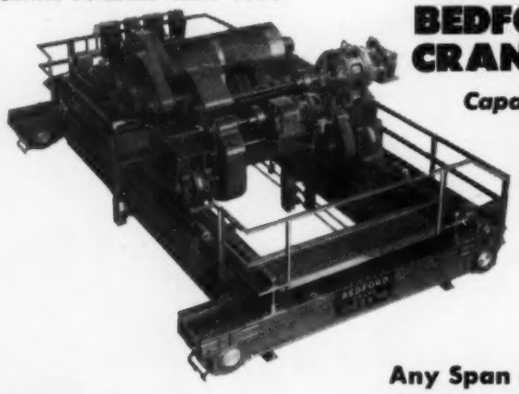
Book Review

▲ The boiler code committee of the American Society of Mechanical Engineers announces that its special committee to revise section VIII of the ASME Boiler Construction Code (Unfired Pressure Vessel Code) has just completed its work and has submitted a report to the boiler code committee in draft form as a proposed revision of Section VIII, dated January 1947.

One of the outstanding features of the new draft is the development of a more logical arrangement of material, which closely follows that in the API-ASME Unfired Pressure Vessel Code. The basic minimum requirements are essentially those established in the alternate rules for unfired pressure vessels, issued as a part of the 1944 addenda to the code. Besides improved arrangement, the proposed revision embodies the following additional features: (1) Improved and extended rules for the design of formed heads under internal and external pressure; (2) provision for the design of cylindrical shells under external pressure at elevated temperature; (3) joint efficiency for fusion welded vessels established on a premium basis; (4) spot examination of fusion-welded vessels as a minimum requirement; (5) incorporation of a non-mandatory appendix as a guide for the inspection of vessels in service.

The boiler code committee invites all interested persons to review the proposed revision and to submit comments thereon to the committee. The new draft is obtainable from J. W. Shields, secretary of the committee, ASME, 29 West 39th Street, New York 18, New York, at $1 per copy.

CRANE BUILDERS Since 1903



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Capacities 5 to 150 Tons

Designed and Engineered to Meet Your Requirements

Any Span or Lift Send For Your Copy Of Catalog

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BUILT TO YOUR SPECIFICATIONS
STRUCTURAL STEEL • STEEL BUILDINGS
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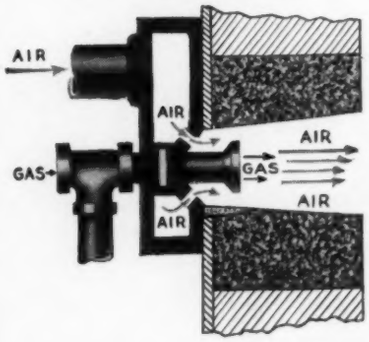
Gray Iron Castings

THE BLOOM TEMPERED-FLAME BURNER



BURNS AS LONG AS IT HAS FUEL!

Providing unparalleled flexibility of furnace operation, the Bloom Tempered-Flame Burner can be used for furnace temperatures from 2600°F to 400°F. It will light at full capacity, and will not go out as long as fuel is supplied. It operates with great stability throughout all ranges of fuel-air ratios. A unique principle of design gives this highly valuable flexibility.

Full details will be furnished upon request.

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Modern Morgan Rolling Mills have been specifically developed by skilled technical pioneers to meet the demands of mass production. Their contributions, as partially listed at the left, have given industry the rolling mill equipment it needs to produce . . . more products . . . better products . . . at less cost.

Made with skill, Morgan equipment produces larger tonnages easier, with greater safety. Bring your problem to Morgan.

Continuous Billet and Sheet Bar Mill
Continuous Skelp Mill
Continuous Mill—Twist Guides
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Steam Flying Shear
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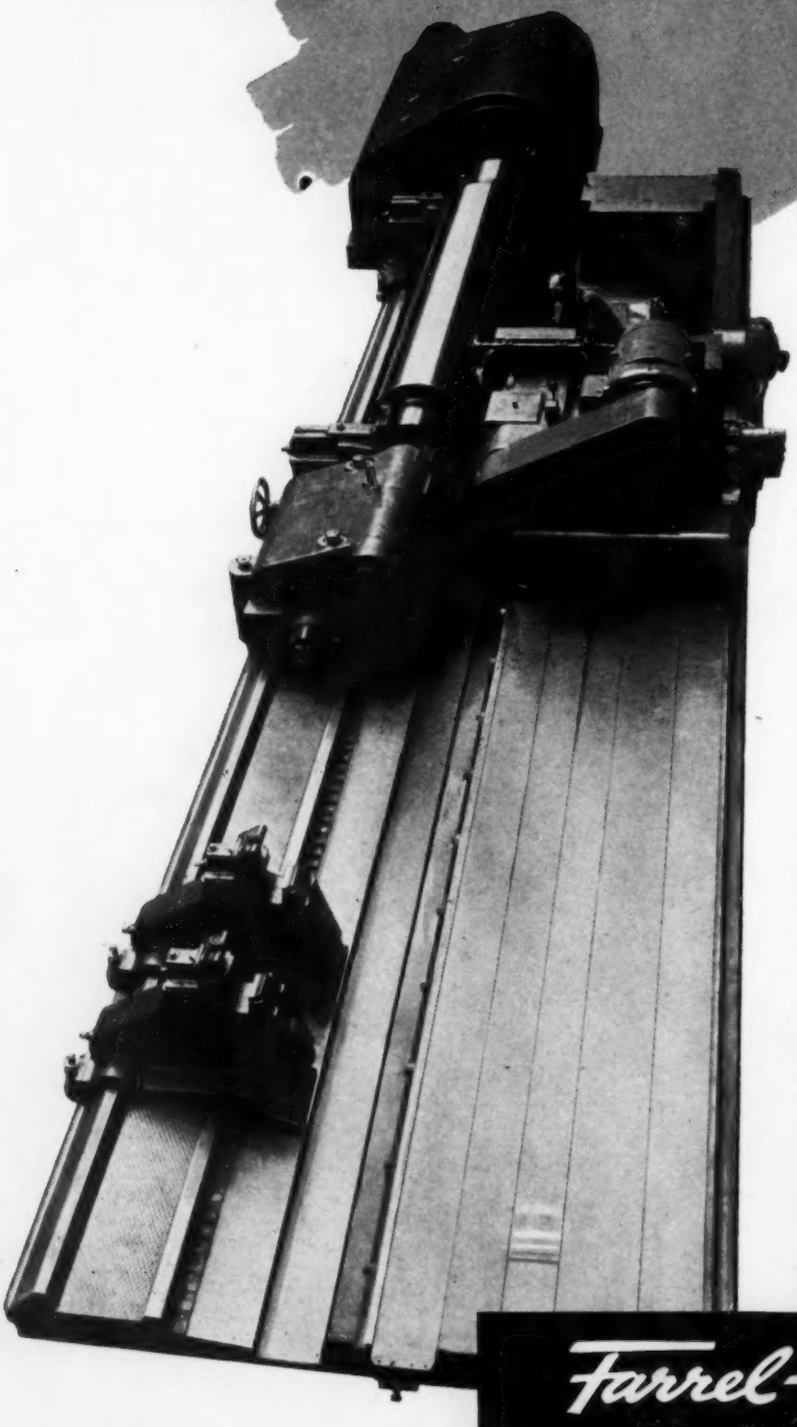
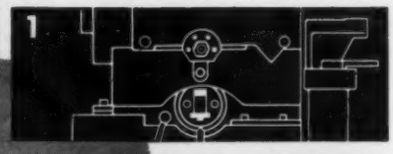
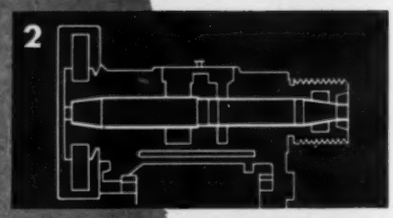
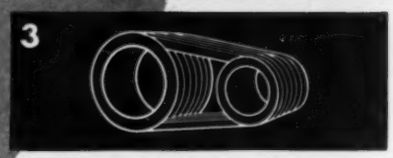
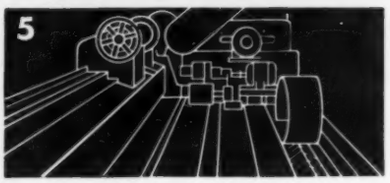
WHAT GIVES THIS 60" ROLL GRINDER AUTOMATIC PRECISION











Five important design features that contribute to automatic precision in this big Farrel grinder are:

1. AUTOMATIC CROWNING AND CONCAVING DEVICE—This built-in "brain" automatically produces a mathematically accurate curve for either a crowned or concaved roll, with both halves perfectly symmetrical. The same setting invariably produces exactly the same curvature.

2. GRINDING WHEEL SPINDLE—Of large diameter for rigidity under working load—made of high grade alloy steel, heat-treated and precision ground—mounted in adjustable bearings, automatically lubricated.

3. WHEEL SPINDLE AND HEADSTOCK DRIVES—Work and wheel are both driven through multiple V belts. Their smooth, vibrationless transmission of power safeguards precision.

4. TWO DEAD CENTERS—Dead center in the headstock as well as in the footstock insures concentric rotation of the work, which contributes to precision grinding of journals and bodies.

5. INVERTED V WAYS—Cast separately from the bed, of a special grade of alloy iron, they are exceptionally resistant to wear, maintaining their accuracy for a long life. Automatically pressure-lubricated and covered by flexible metal guards to exclude dirt and grit.

Farrel roll grinders are available in two types—Type HD shown here, and Type TT which has a traveling work table. Complete details of either type will be sent promptly on request.

FB-366

FARREL-BIRMINGHAM COMPANY, INC.

ANSONIA, CONN.

Plants: Ansonia, Derby and Stonington, Conn., Buffalo, N. Y.
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CROUSE-HINDS

50th Anniversary

HALF A CENTURY OF ACHIEVEMENT

1897 Fifty years ago two men each had an idea. Huntington B. Crouse had an idea. He wanted to be a business man. Jesse L. Hinds had an idea. He wanted to manufacture articles for the electrical trade. A mutual friend brought the two men and their ideas together and on January 18, 1897 the Crouse-Hinds Electric Company was born. It manufactured electrical switches, panelboards, switchboards, and the patented Syracuse Changeable Electric Headlight for trolley cars. The headlight was the forerunner of the extensive line of lighting equipment manufactured later.

1903 The partnership was replaced by a corporation — Crouse-Hinds Company.

1906 A newly invented line of electrical conduit outlet bodies with threaded hubs was now manufactured. A new name was needed, so the word "CONDULET" was coined. It was adopted as a trade mark and registered in the United States Patent Office. Condulets were destined to revolutionize electrical conduit installation practice.

1910 Mr. Crouse formulated a firm policy of equal discounts to all distributors and equal prices to other purchasers. Revolutionary in those days, it has since been generally adopted by the electrical industry.

1911 On a 25-acre plot of land the cornerstone of the present plant was laid. Additional acres and buildings have been added since.

1915 Crouse-Hinds made the first of its now extensive line of floodlights.

1922 Crouse-Hinds built the first modern four-way three-section traffic signal.

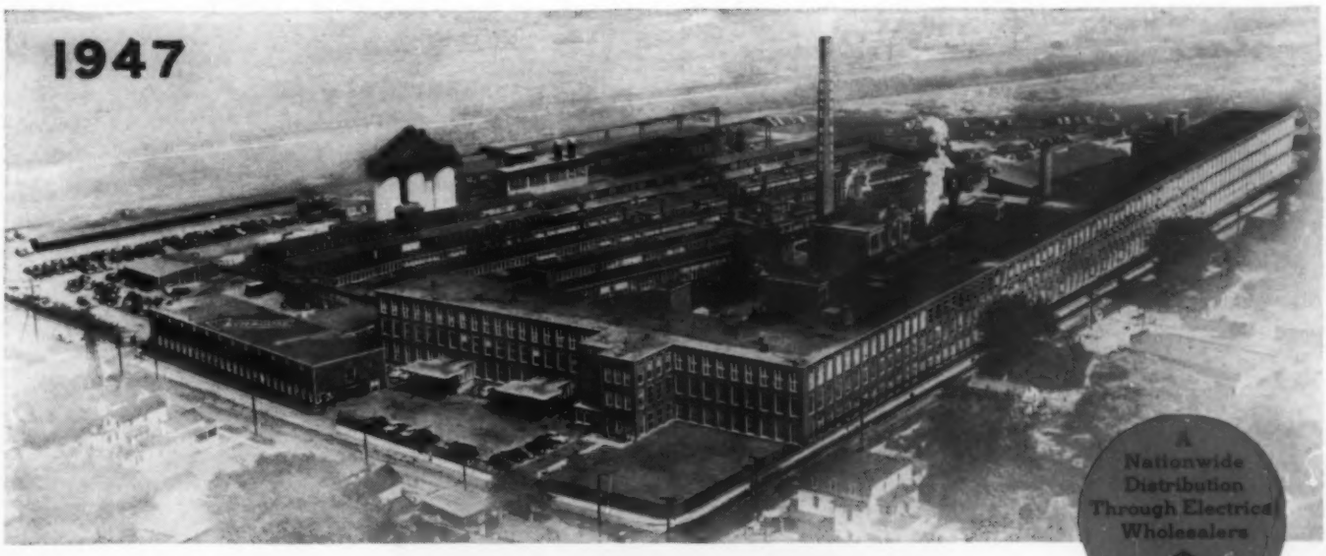
1927 Crouse-Hinds developed equipment especially designed for airport lighting.

1929 Pioneer in sports lighting, Crouse-Hinds installed a complete lighting system in a major college football stadium — at Syracuse University.

1932 Crouse-Hinds issued the first complete catalog of a line of Explosion-Proof Condulets.

1943 Upon the death of Mr. Huntington B. Crouse, Mr. William L. Hinds succeeded him as President of Crouse-Hinds Company.

1947 Now, after fifty years, the Crouse-Hinds Company has the same objectives with which it started — to make a good product better and to deal fairly and honestly with all.



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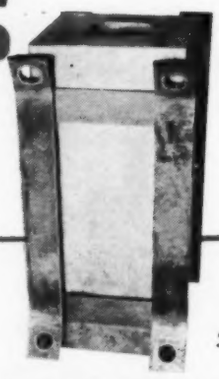
538 INGOTS CAST IN ONE GRAPHITE MOLD!

Using a single "National" graphite mold, a steel company has smashed all records by casting a total of 538 steel ingots. This was accomplished without any process changes, without the use of mold wash, and without treatment of any sort.

In addition to cutting mold costs 77.4%, graphite provided these benefits: Elimination of stickers...better surface condition—less cold lapping ... improved grain structure. Many other advantages in pouring and stripping were obtained.

Every foundryman will want the complete story of this interesting experience with graphite molds. Address National Carbon Company, Inc., Dept. IS.



The graphite mold in which 538 ingots were cast

ADVANTAGES OF GRAPHITE FOR MOLDS:

Will not deform—at any temperature.
No stickers—stripping 30% faster.
Not wet by molten metals.
Heat conductivity 2-3 times that of cast iron.
More uniform cooling.
No mold wash needed—fewer inclusions.

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Personnel News . . . .

R. S. Lynch has been elected president of the Atlantic Steel Company, Atlanta, Georgia. Mr. Lynch began his steel career in the open hearth department of the American Sheet and Tinplate Company, Vandergrift, Pennsylvania. In 1924 he joined the United Alloy Steel Corporation, Canton, Ohio, and since then he has been, successively, assistant superintendent of Republic Steel Corporation's Massillon-Canton stainless division, in addition to being general superintendent of the Massillon steel division. He joined the Atlantic Steel Company as general superintendent in September 1944, and was named vice president this past June. Mr. Lynch is an active member of the Association of Iron and Steel Engineers.

Walter E. Hadley, manager of Chicago district operations for Carnegie-Illinois Steel Corporation has retired. Mr. Hadley, a native of Cambridge, Massachusetts, has been associated with the U. S. Steel family since 1904. He started, after graduating from Massachusetts Institute of Technology with a mining and metallurgical degree, as a clerk in National works of the subsidiary National Tube company at McKeesport, Pennsylvania. He progressed rapidly and became assistant superintendent of blast furnaces of the Tennessee Coal, Iron and Railroad Company's Ensley works in Alabama in 1909 and later, in 1918, was transferred to the Carnegie-Illinois Gary works as assistant general superintendent. He served in this position until 1935 when he became general superintendent. Three years later he was promoted to the district management and since has served in this capacity.

James M. Darbaker has been appointed manager of Carnegie-Illinois Steel Corporation's Chicago district. Mr. Darbaker is a University of Michigan graduate in mechanical engineering and began his steel industrial career while he was still a student, working during summer vacations at the Vandergrift plant of Carnegie-Illinois Steel Corporation.

He became assistant master mechanic of the Vandergrift plant in 1920, later resident engineer of Wellsville, Ohio, works, master mechanic of Chenango works and later master mechanic at the Gary sheet and tin mill. In 1933 he was advanced as assistant to manager of the plant and in 1934 became the works manager. He served as head of the plant until 1943, when he was promoted to the assistant district manager's position.

John R. Comstock has been appointed general superintendent of the Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania. A 1911 graduate of Stevens Institute of Technology with a mechanical engineering degree, Mr. Comstock started with Bethlehem Steel Company at the Steelton, Pennsylvania, plant where he became assistant superintendent of blast furnaces. From 1921 to 1931 he was assistant general manager of the Hanna Furnace Company at Cleveland, Ohio. In 1933 he was appointed general superintendent of the Globe Iron Company at Jackson, Ohio. He became assistant general superintendent of the Pittsburgh Coke and Chemical Company in 1943 and held this position until his present appointment.

Frederick Donald Schreiber has been appointed manager of coal chemicals division of Pittsburgh Coke and Chemical Company, Pittsburgh, Pennsylvania. A 1915 graduate of Lehigh University, Mr. Schreiber became affiliated with Lehigh Coke Company at Bethlehem, Pennsylvania, as a furnace engineer in 1915. In June 1916 he joined Youngstown Sheet and Tube Company at Youngstown, Ohio, as a heater helper. He then went with the old Brier Hill Steel Company, Youngstown, Ohio, where he became by-product foreman, general foreman and subsequently superintendent of the benzol plant. In 1928 he was made coke plant superintendent of the Pittsburgh Coke and Chemical Company advancing to general superintendent and now to his present appointment.

Ed O. Reese has been appointed assistant superintendent of the hot strip mill and **George C. Brainard Jr.** has been appointed assistant superintendent of the cold strip mill at the Campbell plant of the Youngstown Sheet and Tube Company.

Mr. Reese joined the company in 1935 as a time study man, became a hot strip production expediter in 1936, turn foreman in 1935 and day foreman in 1945.

Mr. Brainard began in the blast furnace department during summer vacation in 1938, was transferred to the cold strip department two years later, entered the army in 1941, returned in 1945 and became a turn foreman and advanced to assistant general foreman last May.

Gerald E. Rhodes was appointed assistant manager of American Bridge Company, Gary, Indiana. Since 1943 he has served as assistant to the manager, **William**

R. S. LYNCH

WALTER E. HADLEY

JAMES M. DARBAKER

F. D. SCHREIBER

A. Thiel. Mr. Rhodes in his new post succeeds **Jay K. Thompson,** who has retired after 44 years' service.

Mr. Rhodes is a native of Knottsville, Ky. He was graduated from Notre Dame University in 1917, and after other industrial experience joined the American Bridge Company in Gary in 1931. He started as a draftsman and later became a supervisor.

R. S. Poister has been appointed a vice president of the Crucible Steel Company of America. Mr. Poister attended Carnegie Institute of Technology and Case School of Applied Science. Upon completion of his education, he started in the steel business with the Cleveland Furnace Company, Cleveland, Ohio. Soon after he went to the old United Steel Company, which is now the Canton, Ohio plant of Republic Steel Corporation.

Mr. Poister went with the Youngstown Sheet and Tube Company, Indiana Harbor, Indiana, as assistant general superintendent in the spring of 1936 from the Alan Wood Steel Company, Conshohocken, Pennsylvania, and was promoted to general superintendent in charge of steel and coke plants in 1937. In 1942, he was appointed manager of the Chicago district of the Youngstown Sheet and Tube Company, holding that position until his present appointment with Crucible.

W. H. Williams, who with the late **P. C. Clark** was one of the founders of the Clark Controller Company, served for 20 years as vice president in charge of sales. For the past two years he has been president of the company, and resigned, effective January 31st, 1947, to become chairman of the board, February 1st, 1947.

Robert H. Hoge, with 10 years of service with the company in various capacities from application engineer through vice president and general manager, was elected president of Clark Controller Company, succeeding Mr. Williams, effective February 1st, 1947.

Harry C. Cronk has been appointed chief engineer of plant construction, Dorman, Long and Company, Ltd., Middlesbrough, Yorkshire, England. Prior to his new appointment, Mr. Cronk was chief engineer for Richard Thomas and Baldwins, Ltd., Ebbw Vale works, Monmouthshire, England.

Robert B. Mears was appointed research laboratory manager in the research and development division of Carnegie-Illinois Steel Corporation. He succeeds **E. S. Taylerson** who recently became supervisor of engineering research for the company.

Dr. Mears since October 1 has been at the United States Steel research laboratory at Kearny, New Jersey. He is a native of Scranton, Pennsylvania, and a 1928 Penn State College graduate in electrochemical engineering.

After four years on the technical staff of Bell Telephone Company, he entered Cambridge University where he was awarded a Doctor of Philosophy degree in metallurgy in 1935. He received Carnegie scholarship and research grants from the British Non-Ferrous Research Institutes and Sydney-Sussex College. Important chemical metallurgy positions with the Aluminum Company of America were held by Dr. Mears before he joined Carnegie-Illinois Steel Corporation.

Dr. Laurence C. Hicks has been appointed assistant director of research of the Allegheny Ludlum Steel Corporation. Dr. Hicks, who has been with the organization since 1933 when he started in the research laboratory of the Allegheny Steel Company, was associate director of research in charge of magnetic steel and allied products at the time of his promotion.

William J. Baldwin, of the research laboratory at Allegheny-Ludlum Steel Corporation's Watervliet, New York plant, was appointed chief plant metallurgist.

J. Robert Ferguson, Jr., has been appointed assistant chief engineer of the South Chicago plant of Carnegie-Illinois Steel Corporation. He succeeds **H. L. Lietz** who has been appointed chief design engineer.

Mr. Ferguson has been in the corporation's engineering department since 1940 and has served in both the Pittsburgh and Chicago districts. He is a graduate of the Massachusetts Institute of Technology.

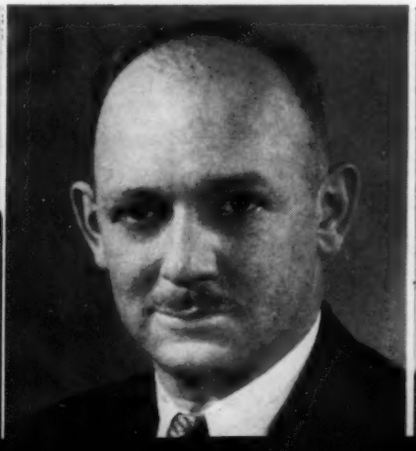
Hubert Merryweather, general manager of ore properties, Bethlehem Steel Company retired recently. Mr. Merryweather had been with Bethlehem Steel for 36 years. In February 1910 he went with Bethlehem Steel Company as mine superintendent of the Juragua Iron Mines Company in Cuba. He later became general superintendent. In 1913, when Bethlehem acquired the Tofo iron mines properties in Chile, he was sent to take charge there as vice president and general manager. At the conclusion of the construction work he was called to Bethlehem as mining engineer under the late **C. A. Buck.**

After a short period Mr. Merryweather left the company and engaged in business for himself in Cleveland, Ohio. On the death of the manager of the Juragua iron mines he returned to Cuba for Bethlehem as vice president and general manager of the newly formed Bethlehem-Cuba Iron Mines Company. He remained in Cuba until 1928, when he was again recalled to

R. S. POISTER

W. H. WILLIAMS

ROBERT H. HOGE



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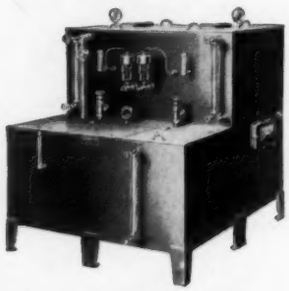

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Bethlehem as mining engineer in the raw materials department. He was made general manager of ore properties September 1, 1939.

A. S. Hellstrom was appointed chief engineer for the Youngstown Foundry and Machine Company, Youngstown, Ohio. Mr. Hellstrom was formerly associated with the Arms-Franklin Corporation.

V. E. North has been appointed vice president and general manager of Hamilton, Ontario, Canada office of the Eastern Electric Construction, Ltd. Mr. North was formerly manager of the Ontario district of the English Electric Company of Canada, Ltd.

Harry E. Orr has been appointed general manager of operations of the Bridgeville, Pennsylvania and Niagara Falls, New York plants of the Vanadium Corporation of America.

Fred E. Harrell, general works manager and a director of the Reliance Electric and Engineering Company, has been elected manufacturing vice president of the company. Mr. Harrell has been with Reliance since he graduated in electrical engineering

FRED E. HARRELL

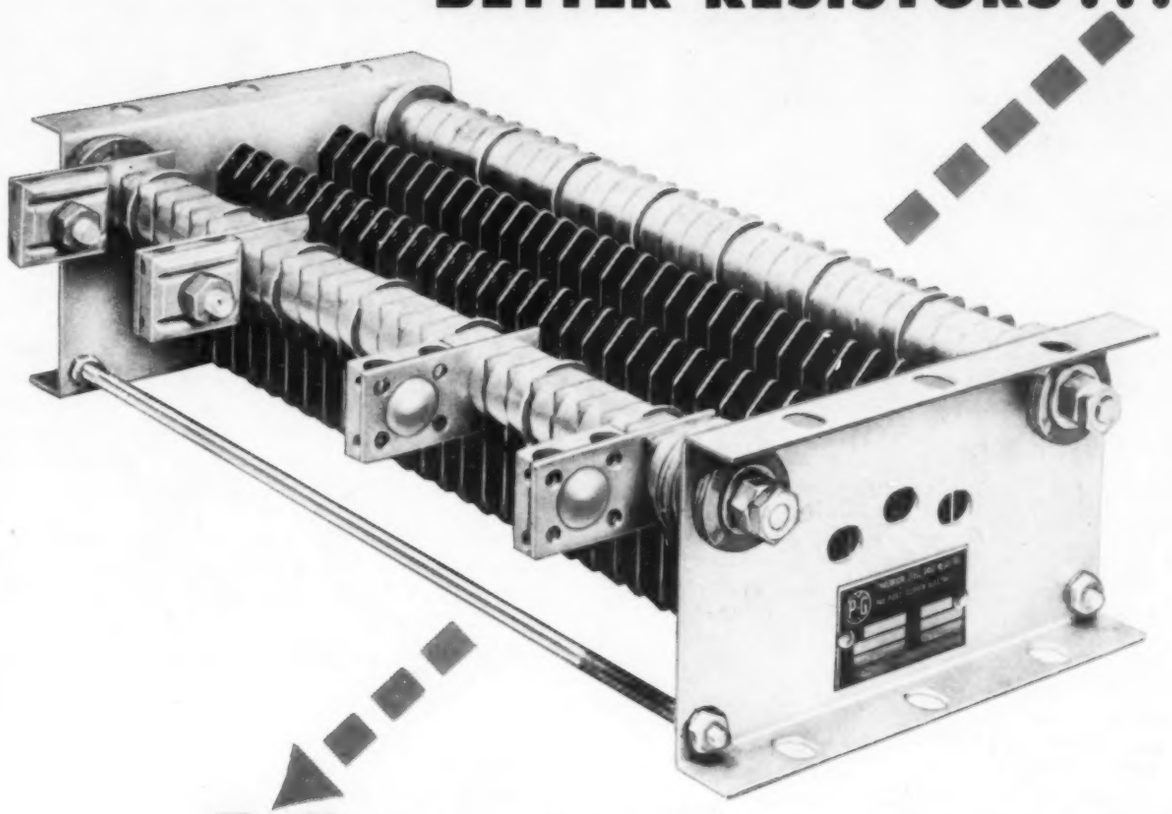
from Purdue University in 1924. He was made assistant chief engineer in 1934, served as executive director of the company's marine division plant during the early part of the war, became chief engineer of the company in 1943, and general works manager in 1945.

Alexander L. Feild has been appointed associate director of research laboratories of the American Rolling Mill Company of Middletown,Ohio. Mr. Feild, who had been director of research laboratories of the Rustless Iron and Steel Corporation, prior to that company's entrance into the Armco organization, will be in charge of research on wire, bar and flat-rolled stainless steel products. He will continue his office in Baltimore and spend a portion of his time at the Middletown Laboratories.

D. M. Morewood was appointed assistant vice president, traffic department of United States Steel Corporation of Delaware. Mr. Morewood was employed by Carnegie Steel Company in 1914 and has been engaged in traffic work for the operating companies o

SEVERE MILL SERVICE *Demands*

BETTER RESISTORS...



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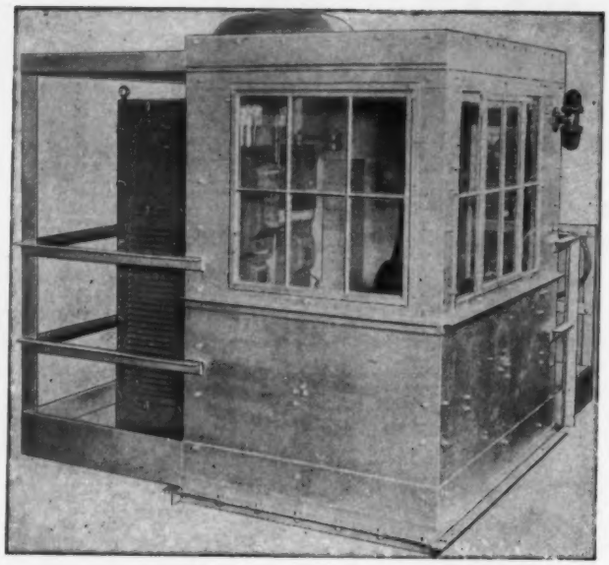

14 Lintern Aire-Rectifiers
for General Purpose Cranes in a Western Steel Plant.

These two views show a Lintern Aire-Rectifier on a general purpose crane. The crane operates in temperatures up to 140° and the Aire-Rectifier pulls the temperature in the cab down to 82° to 85°.

Furthermore, the Aire-Rectifier has activated carbon canisters for the removal of fumes and gases, thereby assuring clean, healthful air for the operator. Another feature of this job is the heating equipment — heater to provide comfortable temperatures in winter operation.

The installation involved 14 Lintern Aire-Rectifiers to condition the crane cabs of all the general purpose cranes operating in excessive temperatures in this plant.

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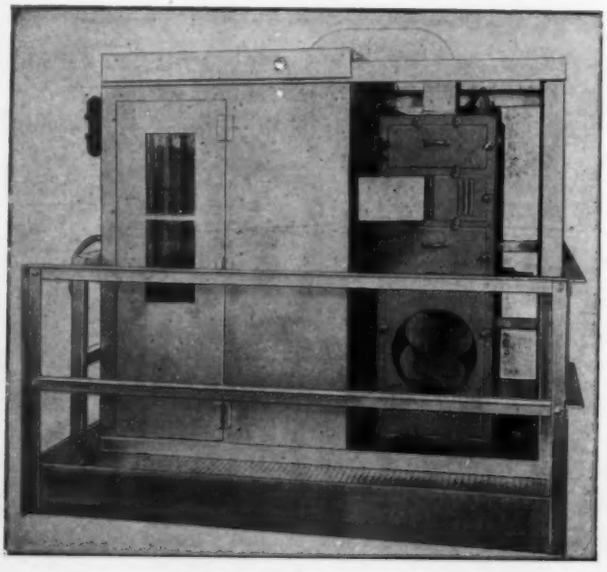

U. S. Steel since that time. He joined U. S. Steel as an assistant to **Mr. Plowman** early in 1944.

Prior to that time he had been assistant traffic manager for Carnegie-Illinois Steel Corporation and other U. S. Steel subsidiaries in the eastern district.

Harry T. Silverman was appointed assistant superintendent of the shops department at Youngstown Sheet and Tube Company, Indiana Harbor, Indiana. Mr. Silverman attended Carnegie Institute of Technology and Washington and Jefferson College where he received a bachelor of science degree. He was in the Youngstown Sheet and Tube Company's Youngstown district industrial relations department before he was transferred to a similar position in the Chicago district, subsequently being placed in the shops department at the Indiana Harbor works.

R. S. Keefer, formerly sales manager, has been appointed vice president in charge of sales and will be responsible for directing all sales activities of the Okonite Company, Passaic, New Jersey and its Hazard Insulated Wire Works division, as well as those of its affiliate, the Okonite-Callender Cable Company, Inc.

William R. Balph has been appointed works metallurgist of Cuyahoga works, Cleveland, Ohio, of American Steel and Wire Company. At the same time, **Stuart J. Kelley** has been appointed division metallurgist in the cold roll department at the same plant, succeeding Mr. Balph.

Mr. Balph has been associated with the wire company since February 1936, and has been cold roll division metallurgist since May 1944.

Mr. Kelley started with American Steel and Wire Company in June 1933, at the Consolidated works in Cleveland and held a number of positions before being made product metallurgist at the Cuyahoga works in February 1943.

William R. Miller has been appointed assistant manager of the metallurgical department of American Steel and Wire Company, United States Steel subsidiary. **John F. Occasione** has been made division metallurgist in charge of process control, while **Merle H. Seifert** has been named division metallurgist, fine wire.

Mr. Miller first started with American Steel and Wire Company in February 1936, as an observer at the company's Cuyahoga works in Cleveland, Ohio. He has held a number of positions in the intervening years, the last one being works metallurgist at Cuyahoga works.

Mr. Occasione's experience with the company dates back to March 1934, when he started as a cold roll operator at Cuyahoga works. He subsequently worked at Consolidated and Newburgh works before being transferred to the Cleveland office, where in January 1945, he was named division metallurgist, fine wire.

Starting with the company in May 1937, as an observer in the hot mill of Cuyahoga works, Mr. Seifert has also had wide experience in the company. Prior to his latest appointment, he was division metallurgist in the Cleveland office.

William W. Gould, field engineer of the Edison Storage Battery division of Thomas A. Edison, Inc., since February 1943, with headquarters at the company's Philadelphia district office, has been appointed

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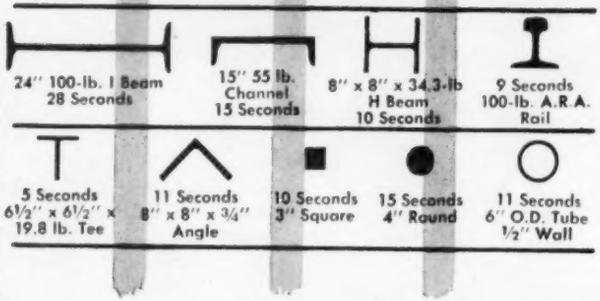

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Because of its versatile ability to cut many varied structural shapes, as well as solid or hollow bars in any sequence, without change of blade or set-up, one machine can handle a volume of cutting that would otherwise require several separate shears or slow speed saws.

Consult Kling engineers regarding your metal cutting problems. State size of material to be cut. Bulletin No. 9200 giving full particulars and suggestions as to the type and size of saw will be mailed promptly. No obligation.

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Cleveland district manager. Mr. Gould began his career as a draftsman on the Canadian Pacific Railway in 1923. A year later he became associated with the Illinois Central as draftsman and was advanced to chief inspector. In 1930 he joined the Lackawanna Railroad as construction foreman. In February 1931, he was appointed electrical supervisor of the Reading Company, which position he held until he joined the Edison Industries in 1943. He succeeds **Alva E. Radcliffe** who has been district manager at Cleveland since June 1941 and was formerly, since 1926, sales representative with headquarters in the company's Chicago district office. Mr. Radcliffe has become associated with B. I. Florey, Cleveland representative of the Automatic Transportation Company.

H. C. Crawford has been elected vice president in charge of traffic for Bethlehem Steel Company. Born in South Bend, Indiana, and educated in local schools, Mr. Crawford's first business experience was with the traffic division of United States Steel Corporation. In January 1914 he became a special agent for Cambria Steel Company; was appointed its eastern traffic manager in 1915, from whence he moved to the Midvale Steel and Ordnance Company as traffic manager.

When Bethlehem acquired Midvale in 1923, Mr. Crawford came to Bethlehem as assistant general traffic manager; in 1927 he became traffic manager; and in 1937 general traffic manager, in which capacity he has served until the present time.

F. M. Huffman has been appointed general traffic manager for Bethlehem Steel Company. Mr. Huffman, a native of Bethlehem, Pennsylvania, educated in the local schools, and a graduate of Lehigh University in 1922, has been affiliated with the company throughout his business life. He has been located successively in Philadelphia, Chicago, St. Louis and Baltimore, and in 1940 was transferred to the general headquarters of the company at Bethlehem as assistant general traffic manager. In 1944 he was made traffic manager.

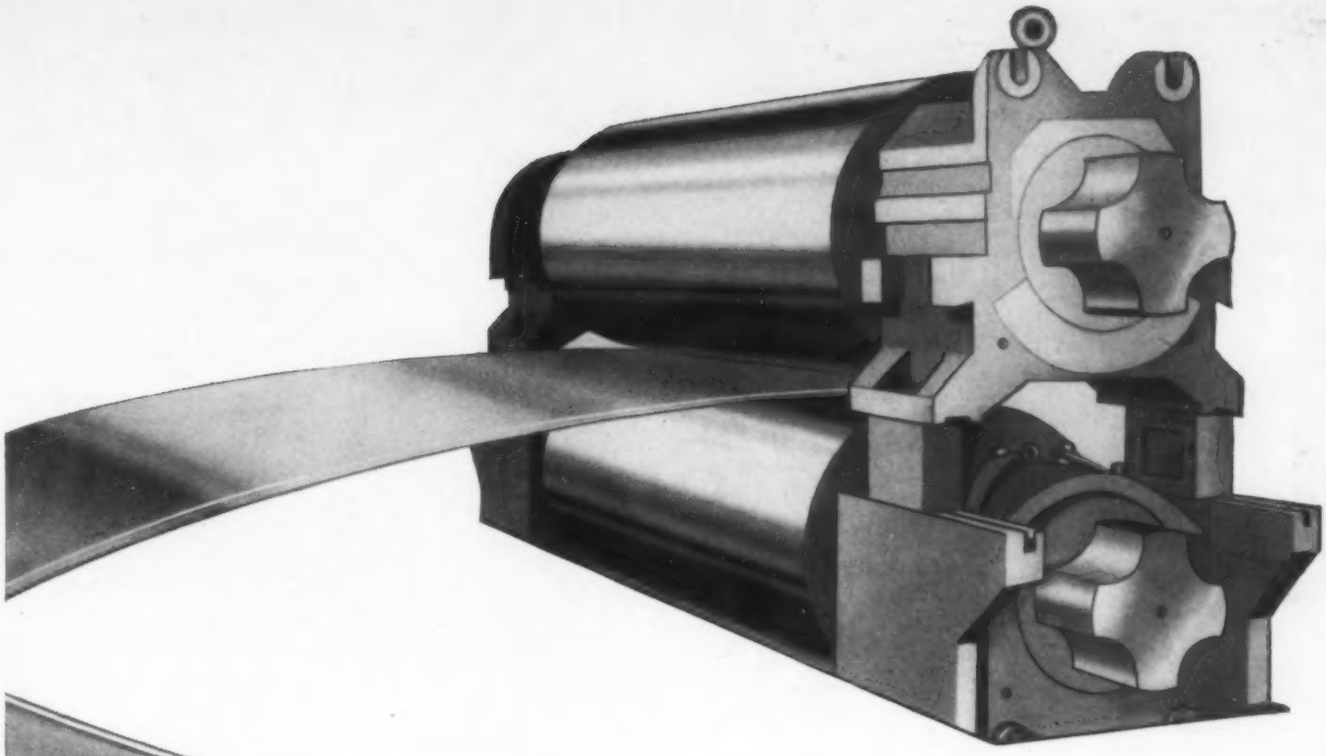
J. M. Gross, vice president in charge of traffic, Bethlehem Steel Company, has retired. He went to Bethlehem October 1, 1917 from the post of assistant general freight agent for the Pennsylvania Railroad. At that time he was named general traffic manager for Bethlehem Steel, and for the past 20 years he has been vice president in charge of traffic.

Maynard J. Rich has been appointed assistant plant industrial engineer at Carnegie-Illinois Steel Corporation, Duquesne, Pennsylvania. Mr. Rich has served in industrial engineering departments of Vandergrift, Homestead and Duquesne works at Carnegie-Illinois Steel Corporation.

William R. Milliken has been appointed assistant to chief metallurgist, alloy steel at the Duquesne, Pennsylvania, works of Carnegie-Illinois Steel Corporation.

David S. Llewelyn, Jr. has been appointed assistant to chief metallurgist, inspection at Duquesne, Pennsylvania, works of Carnegie-Illinois Steel Corporation.

Robert D. Lake was made plant industrial engineer for the Duquesne, Pennsylvania, works of the Carnegie-Illinois Steel Corporation. Mr. Lake had been assistant plant industrial engineer since March 1944.



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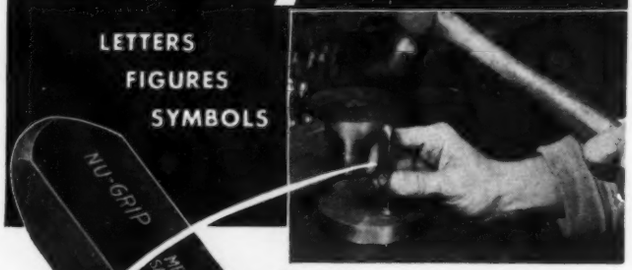

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AISE PAST PRESIDENT DIES

SAMUEL S. WALES

Samuel S. Wales, 76, died of a heart attack on February 3, 1947. Mr. Wales graduated from Rose Polytechnic Institute in 1891 and started to work with the General Electric Company at Lynn, Massachusetts. In 1893 he entered the employ of the Carnegie Steel Company, and in 1894 transferred to the Ohio Steel Company as electrical superintendent. After five years service with the Ohio Steel Company, Mr. Wales was appointed electrical superintendent of the Homestead, Pennsylvania, works of the Carnegie Steel Company (now Carnegie-Illinois Steel Corporation). In 1905 he was made superintendent of the armor plate department and served in this capacity until 1915. He then spent the greater portion of two years in Europe in special metallurgical work. In 1916, he was appointed chief electrical engineer of all Carnegie plants and held this position until his retirement in August 1932. Following his retirement he was associated with the Youngstown Welding and Engineering Company as assistant to the president and plant engineer.

Mr. Wales served as president of the Association of Iron and Steel Engineers in 1927, and was a member of the board of directors for several years. He also served on many of the AISE national committees, contributed many valuable papers and was chairman of the committee that prepared the original specifications for heavy duty electric overhead traveling cranes, which are used throughout the iron and steel industry. Since 1928, Mr. Wales has served as a member of the AISE advisory committee.

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The 1773 Warehouse Type Metal Slitting Machine is a compact unit. The housings, payoff, winder and motor drive are all mounted on a single welded steel base, reducing floor space to approximately 4' x 6'.

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SPEED—150 F. P. M.

CUTTERS AND CUTTER ARBORS—Cutters (separately quoted) are 5½" diameter, of either alloy tool steel or hi-carbon, hi-chrome steel. Arbors are of steel, 2⅝" diameter, with ½" x ½" key.

ADJUSTMENTS—An exclusive feature is a manual adjustment of the top arbor to compensate for wearing down of the cutters. Simple, manually operated spur gears rotate the eccentric arbor bushing at each housing, providing a total adjustment of 9/16".

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DRIVE—Standard make motor, 5 H.P., 1800 R.P.M. Drive to winder through Link leather belt.

***The number "1773" indicates that this is the one thousand seven hundred and seventy-third complete and original design planned on the drafting boards of the Torrington Manufacturing Company. The number of machines built for the metal mills is many times that figure.**

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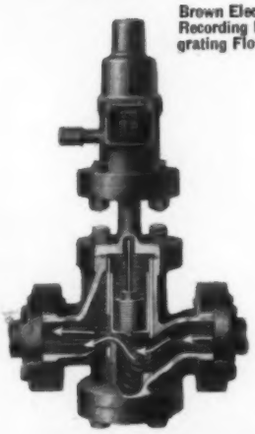

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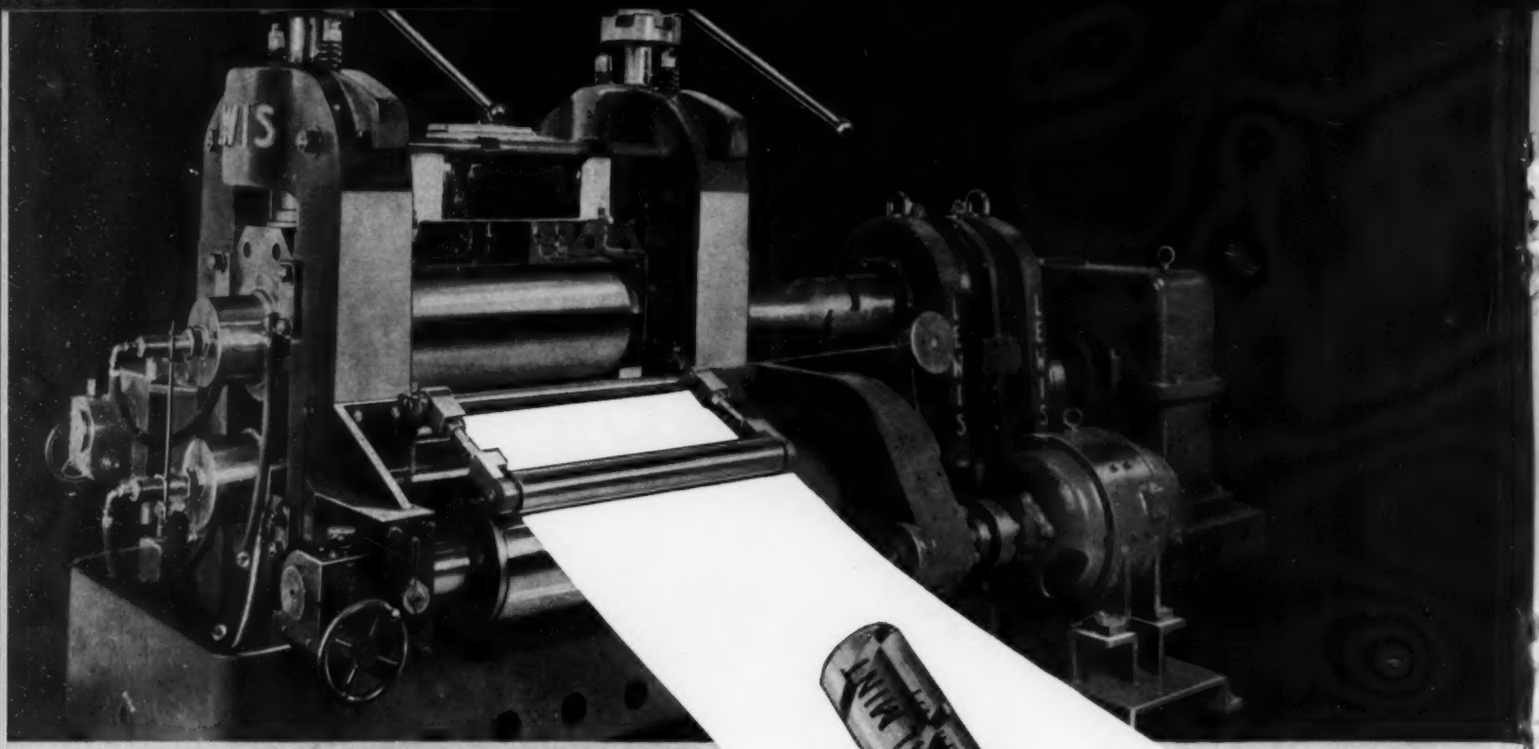

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Weigh ALL the facts

before you buy Insulating Firebrick

Properties of the Johns-Manville Brick and Fireblok Insulation Line

PROPERTIES	INSULATING BRICK			INSULATING FIREBRICK AND FIREBLOK			
	Sil-O-Cel Natural	Sil-O-Cel C-22	Sil-O-Cel Super	JM-1620	JM-20	JM-23	JM-26
Density—lb. per cu. ft.	30	38	40	29	35	42	48
Transverse Strength—lb. per sq. in.	140	115	90	60	80	120	125
Cold Crushing Strength—lb. per sq. in.	400	700	300	70	115	170	190
Linear Shrinkage—Percent	1.4 @ 1600F	0.8 @ 2000F	2.0 @ 2500F	0.0 @ 2000F	0.0 @ 2000F	0.3 @ 2300F	1.0 @ 2600F
Reversible Thermal Expansion—Percent	0.1 @ 1600F	0.7 @ 2000F	1.3 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F	0.5—0.6 @ 2000F
Conductivity at Mean Temperature	∥ ⊥						
500F	1.01 .67	1.67	1.70	.77	.97	1.51	1.92
1000F	1.13 .79	1.88	1.95	1.02	1.22	1.91	2.22
1500F	1.24 .90	2.08	2.19	1.27	1.47	2.31	2.52
2000F	— —	—	2.45	—	1.72	2.70	2.82
Recommended Service							
Back Up	1600F	2000F	2500F	2000F	2000F	2300F	2600F
Exposed	—	—	—	1600F	2000F	2300F	2600F
Recommended Mortar for Setting Brick	Sil-O-Cel Mortar	Sil-O-Cel Mortar	Sil-O-Cel Super Brick Mortar	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement	J-M No. 1626 Cement

Note: 1. Above tests are in accordance with ASTM tentative standards.
2. Conductivity is expressed in Btu in. per hr per sq ft per deg F at the designated mean temperatures.
3. ∥ —with heat flow parallel to brick strata.
⊥ —with heat flow perpendicular to brick strata.

In Insulating Firebrick, it's the correct BALANCE of thermal and physical PROPERTIES THAT COUNTS!

AS THE CHART SHOWS YOU—each of the seven types of J-M Insulating Brick and Insulating Firebrick is designed to do a special job . . . and do it well!

The three J-M Insulating Brick provide great structural strength, the four J-M Insulating Firebrick combine strength with exceptional resistance to spalling. All seven offer the advantages of light weight and low conductivity. They are recommended as back-up insulation or insulating firebrick for all industrial requirements.

For all the facts, write Johns-Manville, Box 290, N. Y. 16, N. Y.

JOHNS-MANVILLE JM PRODUCT

Johns-Manville *First in* Insulations

As the white outline indicates, a standard unit of much greater frame size would be required to do the work of Speedaire.

Space Limited...used SPEEDAIRE

TO operate this Coal Conveyor at a New Jersey aluminum plant, Speedaire was installed for these four excellent reasons:

1. **Space was at a premium and demanded a right-angle worm-gear drive.**
2. **With the powerful, compact fan-cooled Speedaire unit, a further saving of space was obtained.**
3. **Speedaire reduced the weight on structural supports by 285 pounds.**
4. **Speedaire saved $39.50 over the cost of a conventional unit.**

Speedaire is Cleveland's new fan-cooled worm-gear speed reducer. Because it is fan-cooled, Speedaire will do more work —will deliver up to *double the horsepower* of standard worm units of equal frame size, at usual motor speeds. It can be installed economically on many applications where other types have been used heretofore—giving you the advantages of a compact right-angle drive. Speedaire gives the same long, trouble-free service characteristic of all Clevelands.

For full description, send for Catalog 300. The Cleveland Worm & Gear Company, 3278 East 80th St., Cleveland 4, Ohio.

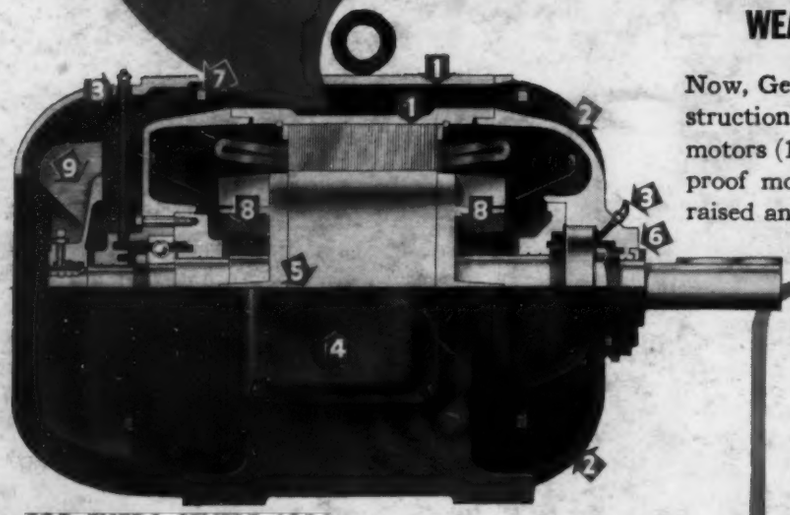
Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

A DOUBLE WALL *Keeps trouble out*

NEW *TRI/CLAD* TOTALLY ENCLOSED MOTOR IS MORE FULLY PROTECTED FROM DUST, DIRT, WEATHER, OR WHAT-HAVE-YOU . . .

Now, General Electric has applied Tri-Clad construction to its line of totally enclosed induction motors (1 to 1000 hp) and to most of its explosion-proof motors as well. *Extra protection* has been raised another notch.



FOR EXTRA-SEVERE JOBS

Applications amid abrasive dust and corrosive atmospheres, such as coke conveyors, sintering plants or pickling line drives and auxiliaries, where totally enclosed motors have been standard, now have the benefit of stronger armor plus convenient servicing features.

FOR EXTRA-WET LOCATIONS

Indoors or out, on blast furnaces or on roll coolant pumps, these Tri-Clad totally enclosed motors will withstand rain and hydraulic spray without danger of shutdown. The cast-iron frame is strongly resistant to rust and corrosion.

HAZARDOUS ATMOSPHERES

Tri-Clad explosion-proof and dust-explosion-proof types are listed by the Underwriters' Laboratories for Class I Group D, Class II Groups E, F, and G applications, such as in coke by-product plants.

FOR EXTRA LONG LIFE

Many motor users are making the totally enclosed motor their standard for *all* jobs—based on evidence of long-term savings. This new member of the Tri-Clad line makes this decision more logical than ever.

THESE 9 POINTS

of new strength and serviceability put this Tri-Clad totally enclosed motor way ahead

1. A cast-iron, double-wall frame that completely encloses windings and punchings

2. Ribbed cast-iron end shields, machined to provide a tight seal, yet easily removed

3. Well proved pressure-relief greasing systems which can be packed with a long-life lubricant where advisable

4. Cast-iron conduit box diagonally split for wiring convenience (independently explosion-proof on explosion-proof motors)

5. Leads are sealed in a nonshrinking compound at the point where they emerge from frame

6. Rotating, labyrinth seal prevents infiltration of grit or liquids

7. Large, free-flowing, easy-to-clean air passages protect parts from accumulation of dust and foreign matter

8. Modern "ageless" insulation treatment includes Formex* magnet wire

9. Powerful external fan is removable, simplifying maintenance. (Nonsparking type for explosion-proof motors.)

AND IN ADDITION —compactness and short length promote ease of handling and installation.

*Trade-mark Reg. U.S. Pat. Off.

GENERAL ELECTRIC

659-40-5058

FOR THE COMPLETE STORY

GENERAL ELECTRIC COMPANY
Apparatus Dept., Schenectady 5, N. Y.

Please send me GEA-4400, which describes the new Tri-Clad totally enclosed motor.

Please send me GEA-4131, "Motors and Control for Hazardous Locations."

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Company.....

Address.....